THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL.

VOL. 31. Thursday, March 19, 1925. No. 448.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial, 17s. 6d. per annum.
All Subscriptions are payable in advance.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
BESSEMER HOUSE, 5, DUKE STREET, ADELPHI,
LONDON, W.C.2.

Contents.

	PAGE
A Logical Attack upon the Strength Properties of Cast Iron	237
Midland Foundrymen Visit Thorncliffe Ironworks	238
An Electric Furnace Action	238
The Distribution of Graphite in Cast Iron and the Influence of Other Elements on its Strength	239
Foundry Queries	244
Slags and Fluxes	245
Patent Specifications	247
De-sulphurisation, Expulsion of Gases and Refining of Cast Iron	248
The Manufacture of Brass Condenser Tubes, with Some Notes on an Alternative Alloy	249
Correspondence	252
Goliath Electric Travelling Crane at Llanelly	253
Company News	253
Trade Talk	254
Contracts Open	254
Obituary	254
Personal	254
Iron and Steel Markets	256
House Fund for the Institute of Metals	256
The Novel Competition	256

Forthcoming Events.

MARCH 20.

Institute of British Foundrymen (Sheffield Branch):—Lecture at Sheffield. "Gates and Risers," by F. C. Edwards.

Junior Institution of Engineers:—Lecture at Newcastle-on-Tyne, on "Turbines."

Junior Institution of Engineers (London):—Ordinary meeting in London. "Modern Transport." Paper by S. H. Hale.

MARCH 21.

Institute of British Foundrymen (East Midlands Branch):—Ordinary meeting at Loughborough. Paper by H. H. Moore.

Swansea Technical College Metallurgical Society:—General meeting at Swansea. "Some Further Notes Relative to Open-Hearth Steel-making." Paper by E. Williams.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

Institute of British Foundrymen.

PRESIDENT, 1924-25, R. O. Patterson, Blaydon-on-Tyne.

LIST OF SECRETARIES—

General Secretary: W. G. Hollinworth, 38, Victoria Street, London, S.W.1.
Lancashire: T. Makemson, 21, Beresford Road, Gorse Hill, Stretford, Manchester.
Birmingham: H. James Roe, 33, Herbert Road, Bearwood, Birmingham.
Sheffield: R. Village, Albion Foundry, Whittington Moor, near Chesterfield.
Scottish: J. Bell, 60, St. Enoch Square, Glasgow.
London: H. G. Sommerfield, Charterhouse Chambers, Charterhouse Square, London, E.C.1.
Newcastle-on-Tyne: Colin Gresty, 93, Queen's Road, Monkseaton, Northumberland.
East Midlands: H. Bunting, 17, Marcus Street, Derby.
West Riding of Yorkshire Branch: A. Love, 232, Gladstone Street, Bradford.
Wales and Monmouth Branch: J. J. McClelland, M.I.Mech.E., Druslyn, Bishops Road, Whitechurch, Glam.

Welsh Engineers' and Founders' Association.

Secretary: P. J. Griffiths, 20, Fisher Street, Swansea.

Foundry Trades Equipment & Supplies Association.

Secretary: K. S. Bridges, Avenue Chambers, Southampton Row, London, W.C.1.

A Logical Attack upon the Strength Properties of Cast Iron.

Since the inception of the British Cast Iron Research Association everybody at all concerned with the manufacture or use of cast iron has on occasion, either privately or publicly, expressed his views as to the most urgent type of research required. Those engaged in the light castings industry require as much data as possible on the subject of fluidity and contraction; automobile manufacturers favour research which will eliminate the various types of porosity and so on. For everybody, however, there is a fascination in exploring the conditions for the regular commercial production of cast iron of generally higher strength values than those currently obtained. For certain branches of the foundry industry this is of paramount importance. This type of research is one which we feel will be productive of the greatest good for the majority of foundries, for in its conduct allied phenomena, such as length of freezing ranges, would be disclosed.

We suggest that as a basis of the research it should be taken for granted that the quantity and the condition of the graphite in cast iron are the main factors in controlling its strength properties. Steps would then be taken to ascertain the conditions for ensuring the maximum amount of carbon was in the useful (pearlitic) combined condition, and obviously the minimum as graphite. The relationship of the variations of cooling rates from normal to this condition could be established. The influence of the duration of the freezing ranges could also be determined always in relation, of course, to the graphite structure. There is evidence now available to show that the freezing range, which can vary from, say, 50 to 200 deg. Cent., does bear a definite relationship to the distribution and character of the graphite. Now it is also well known that various elements either extend or contract this freezing range, and perhaps a few well-considered experiments would disclose the relative effect and interchangeability of the normal elements. *We do not believe that it is an insuperable task to discover the factors for ensuring a commercial minimum of graphite distributed in its least harmful condition in normal cast iron.* It may be that they are already available, and only the facts require marshalling in proper logical and orthodox sequence for their general acceptance and employment.

Once this phase has been reached and recognised, a common jumping off ground has been disclosed for the true exploration of the properties of "special" cast iron; that is, the influence of elements not normally present except in minute quantities. The result of these additions would require reviewing in two aspects—primarily, as to its influence on the graphite and on the freezing range, and secondly as to its effect upon the matrix.

It is to be hoped that the critical additions will in general be lower than in steel, for which between 10 and 15 per cent. have furnished the most promising results, as is exemplified by manganese, stainless and high-speed steels. Obviously, cast irons with such heavy expensive alloy-additions would be ruled out on economic grounds. On the other hand, if cheap alloy-cast iron could be found which would exhibit 5 per cent. elongation, even though it required a short-duration heat treatment, sufficient would have been accomplished materially to increase the consumption of cast iron at the expense of wrought material.

Midland Foundrymen Visit Thorncliffe Ironworks.

On Saturday, March 7, the Sheffield and East Midland Branches of the Institute of British Foundrymen visited the ironworks of Messrs. Newton Chambers & Company, Limited, at Thorncliffe, near Sheffield. About one hundred and fifty members were present. These works, which were established in 1793, afford an interesting example of the whole series of processes in the manufacture of castings, including the getting of coal; its conversion to coke; the utilisation of the latter in the blast furnace for making foundry pig-iron; and the conversion of pig-iron to finished castings in one of the most extensive general foundries in the country.

The party met near one of the firm's collieries, Thorncliffe Drift, passed the research and general laboratories to one of the batteries of the by-product ovens, where they saw an oven pushed and refilled. This battery consists of forty ovens of the Semet Solvay type. The coal is conveyed by aerial ropeway to the washing plant, where it is washed, screened and elevated into large bunkers. From the bunkers it is passed to the automatic stamping machine, where it is stamped into a cake approximately the same size as the ovens. The machine then moves opposite the oven containing the fully coked charge, which is then pushed out through the oven, quenched and automatically conveyed to the grading and screening plant and loaded into wagons.

From the coke ovens, the party proceeded to the blast furnaces, where they saw a cast of the special "Thorncliffe" foundry iron made. Of the three furnaces, two were in blast and a third rebuilding on modern lines. It may be remarked in passing that the production of iron was the first industry of Messrs. Newton Chambers, and blast furnaces were in operation on the same spot from the end of the century before last.

The combs of pig-iron are carried by overhead electric cranes to the stocking ground where each comb is analysed. As "Thorncliffe" iron is of special quality and is used for fine machinery, etc., the analyses are always miraculously made. In fact, the Company were one of the first to realise the importance of selling to analysis, possibly because of their own foundry experience.

From there the party proceeded to the foundries. The foundries consist of one building 600 ft. wide by 400 ft. long, of fifteen bays of 50 ft. and 33 ft. spans.

They are served by four cupolas each melting 10 tons per hour. The raw material for the cupolas is fed as to the charging platform by two 2-ton electric cranes.

The longitudinal travel of materials in the shop is performed by thirty-four overhead electric cranes, and the cross travel by 50-ton electric bogies, and electric capstans.

The party then saw an 11-ft. tractor type Beardsley & Piper sandslinging machine in operation and also a centrifugal type sandcutting machine electrically driven and propelled by its own motor the full length of the shop, which though extensively used in America, is the only one of its kind in operation in this country.

The large machine-moulding bay was a source of great interest. In this bay are two 500-ton sand bins, each with sand elevators feeding the top and bottom part machines respectively. The empty moulding boxes are placed in position under two fixed centre electric jib cranes. The large roll-over machine, 108 in. by 70 in. of 10,000 lbs. lifting capacity, was made by the Osborn Manufacturing Company, and has a pneumatic jolt and an electric lift. The run-out table is electrically operated from the machine-operating pillar, and has an oil-levelling device. The top part machine is of the electric plain jolt type, and is situated parallel with the run-out table, so that the double-bogied 10-ton overhead electric crane picks up top and bottom part together, and runs them down the shop to be finished, closed, and cast.

The party was afterwards entertained to tea in the canteen, and Mr. T. V. Miles, general manager of the ironworks, extended a welcome. He expressed the hope that they had seen something which had added to their store of knowledge.

Professor C. H. Desch, F.R.S., the Sheffield Branch-President, expressed the thanks of the visitors to Mr. Miles and his colleagues for permission to visit the works, and for the hospitality extended to them, which Mr. S. H. Russell, the East Midlands Branch-President, supported.

Subsequently Mr. R. A. Miles, of the Stanton Ironworks Company, Limited, the Lancashire Branch-President, gave a lecture on "Spun Cast Iron Pipes." The lecture has already appeared in THE FOUNDRY TRADE JOURNAL.

An Electric Furnace Action.

The hearing was concluded in the King's Bench Division, before Mr. Justice Greer, on Monday, of an action by Edgar Allen & Company, Limited, Imperial Steel Works, Sheffield, against Mr. V. Stobie, of Dunston-on-Tyne, in which the plaintiffs claimed a declaration that they were entitled to reject certain furnaces supplied by the defendant and the return of moneys paid and damages for alleged breach of contract.

The interpretation of the terms of the contract between the parties was the point before the Court, the contract being for the supply of electric furnaces for the melting of steel. The plaintiffs alleged that the furnaces were found unsatisfactory after testing, the disputed point being the guarantee regarding the consumption of current. Their case was that the furnaces, requiring 850 to 900 units per ton of steel melted, made them commercially impracticable.

For the defence it was pointed out that neither the purpose for which the furnaces were required nor the consumption of electric power per ton desired were ever communicated to Mr. Stobie nor were such matters within his knowledge. Mr. Stobie also disputed that the tests proved that the furnaces were not in accordance with contract.

Defending counsel stated that the issue was whether there was a warranty or an express or implied term to the effect (1) that the furnaces could produce a given quantity of steel at a consumption of 700 units a ton; (2) that the furnaces could produce a given quantity at a commercially economical cost.

Mr. V. Stobie, the defendant, in the course of his evidence, described a visit by Mr. C. K. Everitt, director of the plaintiff company, to his works, when Mr. Everitt asked for figures which he could lay before his board, and witness replied that the figures he gave were only an estimate, and that as he had no working practice he did not know what the results would be. Mr. Everitt remarked that at any rate he (witness) would maintain that the simple furnaces would run at 600 to 750 units a ton. Witness replied that was the only figure he could assert, and he agreed to embody that in a letter, and did so. He was not asked to contract with regard to current consumption, and was not willing to do so.

In giving judgment, Mr. Justice Greer held that plaintiffs were entitled to rely on defendant's furnaces as an installation which would be commercially useful to them, and defendant's counsel had quite properly admitted that such a clause was implied as a term of the contract. But the question in the issue now being tried was whether there was an express or implied contract that the consumption of electrical power would not exceed 700 units or thereabouts per ton of steel. He did not think either party intended to incorporate in the contract Mr. Stobie's letter. If Mr. Stobie had been required to embody in the contract the information he gave as a matter of opinion in his letter, he would no doubt have refused to do so because the apparatus was new, and no one knew exactly what amount of power it would require, and no business man could expect Mr. Stobie to guarantee the exact amount of power his invention would require. In his Lordship's view the representation in Mr. Stobie's letter was not contractual, and nothing he said at the interview was contractual either. His Lordship held that there was no term, express or implied, in the contract that the installation should produce 200 tons of steel a week with a consumption of 700 units per ton. On those lines the rest of the case would fall to be decided in due course.

The Distribution of Graphite in Cast Iron and the Influence of Other Elements on Its Strength.*

By Matsujiro Hamasumi.

Graphite Distribution in Cast Iron.

Introduction.

A systematic investigation of the mechanical properties of cast iron has not been made since the publication of Coe's paper in 1913.[1] Much has been left to be done up to the present and certainly much remains to be done in the future. Formerly it was assumed that the strength of cast iron is generally between 9 and 14.5 tons per sq. in.

Nowadays the requirements with regard to the strength of cast iron are becoming so large that it is not uncommon to find a specification of 19 tons per sq. in. or more on the tensile test. But it is not so easy to get an iron of such strength. The writer, therefore, considered it necessary to investigate afresh the mechanical properties of cast iron in all its bearings, viz., the effect of rate of cooling, the distribution of graphite, and the effect of common impurities such as silicon, phosphorus, sulphur, manganese, copper, nickel, chromium and tin. This investigation was undertaken to get a correct quantitative result, and not a qualitative one, as was done by previous investigators.

The Effect of Rate of Cooling on the Strength of Cast Iron.

In considering the strength of cast iron, the cooling velocity of casting is one of the most important factors, and it has been studied by F. J. Cook[2], Oskar Lyde[3], and also reported on in the Journal of the American Foundrymen's Association. The method of investigation of these workers was to use test-bars of varying thickness, by which means a variation in the rate of cooling is obtained. But in this method of casting, the maximum rate of cooling was much limited by the diameter of the test-bar and the thermal conductivity of the moulding sand. To get a wider range of cooling rate, the writer, with the object of determining the effect of the graphite form, adopted the method of casting the metal in an iron mould at various temperatures.

Measurement of Cooling Rate.

In order to determine the cooling rate in this method of casting, a preliminary experiment was made by using a cast iron mould of the same dimensions as that used in the subsequent experiments, with an electric resistance furnace of nichrome wire surrounding it.

The mould was heated in this furnace to 400, 500, 600, etc., up to 1000 deg. C., and at each temperature, an alloy, having a composition of 3.5 per cent. carbon and 1.7 per cent. silicon and melted in a 30 kw. cryptol furnace, was cast at 1350 deg. C. Soon after the casting the mould was taken out of the furnace and cooled in the air. The cooling curve was taken for each casting by means of a Le Chatelier thermo-couple inserted horizontally in the specimen, as shown in Fig. 1. The portions of these curves from the highest temperature down to 900 deg. C. are shown in Fig. 2. As the separation of graphite begins at a temperature a little below the eutectic point, and almost ends at 900 deg. C.[4], the amount and distribution of graphite are to be determined by the cooling rate in this interval.

The break in the curve of the primary separation of crystals and the eutectic arrest are gradually depressed from sand mould to the metallic mould at 400 deg. C. owing to the increased speed of cooling. Two observations for each initial temperature of the mould were taken, and the times required to cool down from the beginning of the eutectic arrest to 900 deg. C. are given in Table I.

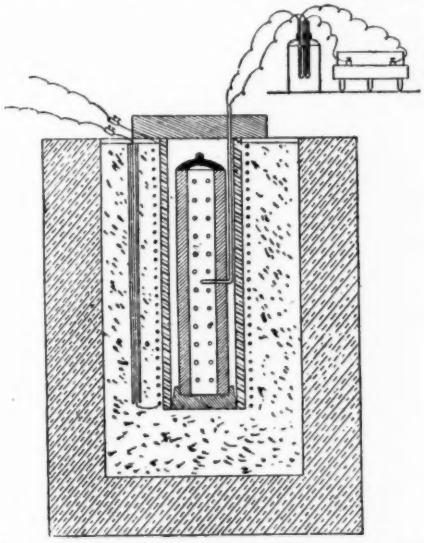


FIG. 1.—EXPERIMENTAL FURNACE AND MOULD.

TABLE I.—*Cooling period in seconds between eutectic arrest point to 900 deg. C.*

Initial temperature of mould in degs. C.	400	500	600	700	800	900	1,000	Sand mould(20)
1st observation	47	57	70	100	140	155	185	300
2nd observation	—	57	75	105	150	150	215	320
Mean (in sec.)	47	57	72.5	102.5	145	152.5	200	310

Cast-Iron Mould.

Judging by the above experiment, the time required for cooling increases proportional to some exponent of the initial temperature of the mould, and the time for a mould at 400 deg. C. is six

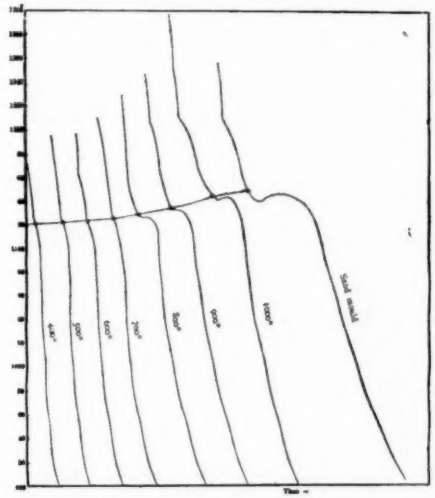


FIG. 2.—COOLING CURVES FROM HEATED MOULDS WITH AN IRON CONTAINING 3.5 PER CENT. CARBON AND 1.7 PER CENT. SILICON.

* Extracted from the Science Reports of the Tohoku Imperial University, Sendai, Japan.

[1] Jour. Iron and Steel Inst. No. 1 (1913), 361.
[2] J. Staffordshire Iron and Steel Inst., 1909-1910.
[3] Stahl u. Eisen (1904), 95, 186.
[4] P. Goerens und N. Gutowsky. Metallurgie, 5 (1908), 137. E. Heyn and O. Bauer, St. u. E. (1907), 1565. Honda and Murakami, Sci. Rep. 10 (1921), 273.

times as great as that for a green-sand mould. The size of the mould was 32 and 57 mm. (1¼ and 2¼ ins.) in inner and outer diameter respectively and 250 mm. (9.8 ins.) in height, its weight being nearly 3.5 kgs. (7.7 lbs.). It consisted of two half-cylinders to facilitate the stripping of the cast specimen, and in each of them two series of holes of 3 mm. (0.12 in.) dia. were provided as vents for the dissolved gases, the escape of molten iron through these holes being prevented by filling with asbestos. This precaution was necessary for the iron casting in metallic moulds; because when there were no holes in the mould, the dissolved gases made their appearance over the whole section as blow-holes, and owing to the strong graphitisation around these blow-holes, the surrounding pearlite was decomposed into ferrite and graphite, which were easily discernible with the naked eye on the polished section owing to its speckled surface.

The inner surface of the mould was coated with graphite, and the two halves were put together, and clamped by iron rings and wedges in three places.

Heating Apparatus for Moulds.

Three moulds of exactly the same size were placed on the asbestos plate in a gas furnace, as shown in Fig. 3. When the moulds were heated to the required temperature, the latter was kept constant for minutes by regulating the amount of heating gases. The temperature was continually measured by the Le Chatelier thermo-couple.

As raw materials, a Swedish charcoal iron containing only slight impurities was used, the com-

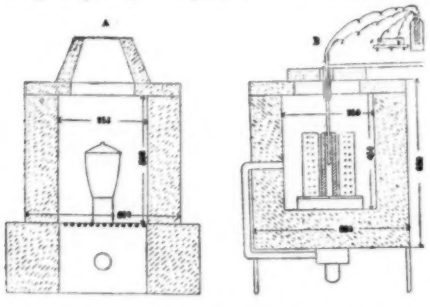


Fig. 3. A. Crucible Furnace Used; B. Pyrometric Control Arrangement. Metric Dimensions are shown.

position of which was as follows:—Total carbon, 3.57; graphite carbon, nil; Mn., 0.21; P., 0.01; S., 0.02; and Si., 0.08 per cent., and different amounts of 50 per cent. ferro-silicon were added to produce a cast iron containing 1, 1.5, 2, 2.5 and 3 per cent. of silicon.

About 11 lbs. of the iron were melted in a small crucible furnace, as shown in Fig. 3. A. The graphite crucible was previously heated to a white heat in order to avoid the dissolution of the superficial graphite into the iron in the first melting. The lid of the crucible was sealed with alumina paste to protect the molten metal from the furnace gases. About forty minutes after the charging of the crucible, when the temperature of the melt had been raised to about 1,500 deg. C., a weighed amount of ferro-silicon was added, and after allowing five minutes in the furnace for the complete dissemination of the silicon, the metal was then cast at 1,350 deg. C.

Soon after the casting, the moulds were taken out of the furnace and cooled in the air. One of the three test-pieces was broken and its fracture was carefully examined, and the other two were machined to the form of tensile test-pieces.

For the specimens to be tested at the normal rate of cooling, green-sand moulds 32 mm. (1¼ ins.) dia. and 250 mm. (9.8 ins.) in height were used, the moulding flasks of which were all 200 mm. (7.87 ins.) square and 300 mm. (11.8 ins.) high.

Testing of the Specimens.

To test the strength of cast iron the transverse test is probably the best method by which the bending of cast iron can be measured, while its toughness is indicated by the deflection of the bar. But the test-pieces for this test are generally very large, so that it is not suitable for laboratory experiments. Hence, for the present, the writer has had to be satisfied with the tensile-test only, leaving the measurement of toughness and elongation for a future occasion.

The tensile test of cast iron is somewhat difficult, owing to its brittleness, due to the presence of graphite flakes, and, therefore, if there is some eccentricity in the application of the load, the specimen breaks even with too low a tension. To avoid this kind of error, the writer replaced the shackle of the Olsen testing machine by spherical seated sockets devised by K. W. Zimmerschied[1], as shown in Fig. 4. With this shackle,

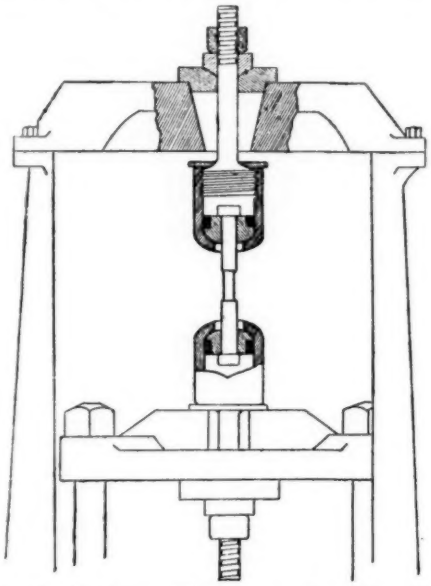


Fig. 4.—Showing Method of Ensuring Concentricity of Load for Tensile Testing.

the breaking in the shoulder of the specimen was avoided.

A considerable difference in the rate of cooling was observed in the section of the bar, especially in the bars cast in the chill mould, their structures varying from the fine one of the outer skin to the coarse in the centre. To keep this difference of structure within a narrow range, specimens with a diameter of 20.26 (.797 ins.) mm., *i.e.*, 322.6 sq. mm. (half sq. in.) in section were made from bars with a diameter of 32 mm.

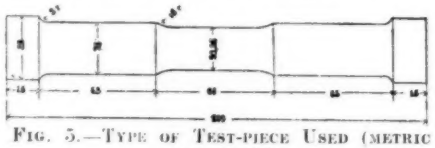


Fig. 5.—Type of Test-piece Used (metric dimensions).

(1¼ ins.). The details of the test-pieces are shown in Fig. 5.

Results of the Mechanical Tests.

The results of the mechanical test of the specimens as well as their chemical compositions are given in Tables II, III, IV and V.

The test-pieces of a series containing 1.2 per cent. silicon and cast in the chill mould at 500 deg. C. were partially chilled into white cast iron in their outer portion, so that they could not be machined and are, therefore, not included. The same remark also applies to the casting in the mould below 300 deg. C. of other series. An important advantage in using a chill mould was that the test-pieces made from the same cast were homogeneous; a difference of 0.31 tons per sq. in. between the two test-pieces was rarely found, which is not the case with bars cast in a sand mould.

As seen from these tables, the strength of the specimens in each series of cast iron increases gradually from the sand-mould casting to the

[1] Trans. Soc. Auto. Eng. 8.

metallic at 600 deg. C., and below this temperature a considerable increase is observed. The writer concludes that the former increase is more or less attributable to a gradual increment of combined carbon, but mainly to the shape and magnitude of the graphite flakes. In the specimen cast in the sand mould straight graphite flakes are found, but in the bars cast in the metallic moulds curved arabesque flakes are formed, while the matrix of pearlite is nearly the same for all specimens cast is, the one cast in green-sand mould. From this fact the writer adopted a content of 1.8 per cent. of silicon for all the bars in subsequent experiments.

The Metallographic Investigation of the Specimens; What is "Graphite-in-Whirl?"

Hitherto it has been believed that besides the amount of graphite, its form has an important bearing on the strength of grey cast iron. Some

TABLE II.—(*Si* 1.2% *Series*).

Test No.	Initial temperature of mould.	Analysis.				Physical Tests.	
		Total carbon %	Graphite carbon %	Combined carbon %	Si %	Maximum stress. Tons per sq. in.*	Brinell No.
1	Sand mould.	3.33	2.43	0.90	1.18	10.07	166
2	1,000° C.	3.41	2·42	0.99	1.06	10.38	174
3	900° C.	3.40	2.43	0.97	1.15	11.48	183
4	800° C.	3.57	2.35	1.22	1.26	11.80	203
5	700° C.	3.38	2.32	1.06	1.08	12.63	199
6	600° C.	3.52	2.26	1.26	1.09	12.66	208

* Mean of two tests.

TABLE III.—(*Si* 1.8 % *Series*).

Test No.	Initial temperature of mould.	Analysis.				Physical Tests.	
		Total carbon %	Graphite carbon %	Combined carbon %	Si %	Maximum stress. Tons per sq. in.*	Brinell No.
1	Sand mould.	3.40	2.45	0.95	1.82	9.35	166
2	1,000° C.	3.46	2.48	0.98	1.74	11.44	189
3	900° C.	3.30	2.45	0.85	1.74	12.93	199
4	800° C.	3.37	2.50	0.87	1.72	13.08	204
5	700° C.	3.38	2.47	0.91	1.58	13.20	203
6	600° C.	3.35	2.45	0.90	1.82	13.34	202
7	500° C.	3.54	2.45	1.09	1.86	13.35	202
8	400° C.	3.52	2.35	1.17	1.92	14.72	218

* Mean of two tests.

TABLE IV.—(*Si* 2.4% *Series*).

Test No.	Initial temperature of mould.	Analysis.				Physical Tests.	
		Total carbon %	Graphite carbon %	Combined carbon %	Si %	Maximum stress. Tons per sq. in.*	Brinell No.
1	Sand mould.	3.37	2.48	0.89	2.30	6.79	127
2	1,000° C.	3.46	2.66	0.80	1.87	8.89	161
3	900° C.	3.60	2.75	0.85	2.10	9.04	167
4	800° C.	3.59	2.59	1.00	2.56	9.70	170
5	700° C.	3.54	2.64	0.90	2.13	10.04	178
6	600° C.	3.66	2.60	1.06	2.33	10.84	195
7	500° C.	3.56	2.46	1.10	2.48	11.56	196
8	400° C.	3.56	2.37	1.19	2.29	12.39	205

* Mean of two tests.

TABLE V.—(*Si* 3% *Series*).

Test No.	Initial temperature of mould.	Analysis.				Physical Tests.	
		Total carbon %	Graphite carbon %	Combined carbon %	Si %	Maximum stress. Tons per sq. in.	Brinell No.
1	Sand mould.	3.35	2.69	0.66	2.90	7.44	148
2	1,000° C.	3.31	2.56	0.75	2.91	9.04	160
3	1,000° C.	—	—	—	—	9.19	—
4	900° C.	3.29	2.52	0.77	3.13	9.19	170
5	900° C.	—	—	—	—	9.07	—
6	900° C.	—	—	—	—	9.28	—
7	800° C.	3.47	2.62	0.85	2.94	9.57	177
8	800° C.	—	—	—	—	10.02	—
9	700° C.	3.46	2.50	0.96	2.90	10.03	183
10	700° C.	—	—	—	—	9.75	—
11	600° C.	3.36	2.51	0.85	2.70	10.57	186
12	600° C.	—	—	—	—	10.17	—
13	500° C.	3.42	2.52	0.90	2.88	11.42	187
14	400° C.	3.56	2.40	1.16	2.91	12.42	202

in the moulds at above 700 deg. C. An example of this curved graphite is found in Micro. No. 1, which is the structure of a bar cast in a chilled mould at 700 deg. C.

The rapid increase in the strength of the specimens cast in the mould below 600 deg. C. is due to a decrease of graphite carbon, as seen from the chemical analyses. Further, it is very interesting to observe that the strength of the specimens of the 1.8 per cent. silicon series is the greatest, though there is one exception in the series—that

years ago Dr. K. Ishikawa of the Naval Arsenal published a Paper on the "Kikumé Structure" of cast iron. According to his view, there are two kinds of graphite form in grey cast iron; one is the well-developed straight or platey graphite, which is found in cast iron containing high carbon or silicon, or both. The other is the "Kikumé Structure," *i.e.*, "graphite-in-whirl," which is mostly found in cast iron containing a moderate quantity of carbon and silicon. The "graphite-in-whirl" is the more desirable kind for cast iron,

XUM

because it has a moderate strength, and its structure is very homogeneous throughout the whole casting, a condition which is most advantageous when making a large casting of varied thicknesses. For the production of such a structure he proposed a composition of about 3.2 per cent. of carbon and 1.7 per cent. of silicon. But the main feature of his research is of a qualitative nature; he did not give the mechanism for producing such a form of graphite. Since cases are often found in which the "Kikumé Structure" is not obtained even

Micro. No. 1. C 3.6 per cent., Si 2.0 per cent., Cast in Metallic Mould, Heated to 700 deg. C. × 120 dias.

when using the above compositions, there must be some other important conditions which are yet to be discovered as to the mechanism or the cause of the production of such curved flakes is completely understood.

On investigating the microstructure of the specimens in the foregoing section, very little difference is found in the metallic matrix, which wholly consists of pearlite, but in the form of graphite a marked difference exists between those in the sand- and in chill-cast samples. Taking

Micro. No. 2. Cast in Sand Mould × 80 dias.

2.4 per cent. silicon series as an example, Micro. No. 2 shows the structure of the specimen cast in the sand mould in which the graphite is all platey and the fracture is open, while the graphite in the specimen cast in the metallic mould at 1,000 deg. C. is somewhat curved, as shown in Micro. No. 3. As the cooling rate is greater, the curving of the graphite flakes becomes more marked, whilst their size is reduced. The same change in the graphite flakes also takes place in the other series of the alloys containing a varying amount of silicon. Hence it is concluded that the true cause producing whirling graphites is the rate of cooling of the castings, and that this is to some extent independent of the composition of the cast iron, and further, that this whirling graphite is another condition that strengthens cast iron, in addition to the increment of combined carbon.

The next question is, then, what is the cause of the whirling graphite? Before entering into the elucidation of the above problem one must first consider the graphitisation occurring in iron-carbon alloys. According to the recent investigations of Professors K. Honda and T. Murakami[6], graphite is the secondary product of the decomposition of crystallised cementite. They attributed this decomposition of cementite to the catalytic action of free gases present in iron, that is, according to the following reactions:—

$$Fe_3C+CO_2=3Fe+2CO$$

and

$$2CO=C+CO_2;$$

and these reactions are strongly accelerated at very high temperatures. There are thus two principal causes for the graphitisation, *i.e.*, the amount of free gases and the time of exposure at the graphitising temperature. In the case of grey cast iron there is another cause to be considered, *i.e.*, the presence of silicon, by which graphitisation is also accelerated. This effect of silicon is generally accepted as due to the great instability of the double carbide of iron and silicon, its chemical formula being not yet known. If the above theory of graphitisation is applied to cast iron containing silicon, the matter becomes very simple.

Micro. No. 3. Cast in Metallic Mould and Heated to 1,000 deg. C.

In hypo-eutectic cast iron, as is generally the case with cast-iron castings, there is a primary crystallisation of austenite in a dendritic form, the boundary of which is rounded by the surface tension at high temperature. Then follows the simultaneous solidification of austenite and cementite, *i.e.*, Ledeburite, in the spaces left between the dendrites of austenite. The size and number of the primary crystals, *i.e.*, austenite, depends solely on the cooling velocity of the melt; thus, when it is small a number of well-developed large crystals are obtained, but when it is large there are numerous small crystals of an irregular form, *i.e.*, the crystals are more uniformly distributed in the latter case, a condition which is necessary for the production of the whirling graphite. Ledeburite is the typical structure of the globular eutectic, consisting of austenite globules in cementite, as studied by C. Benedicks[7] and Brady.[8] The eutectic cementite readily decomposes into graphite and ferrite, the latter forming anew the austenite by dissolving graphite or cementite. The graphite thus produced incidentally assembles round the eutectic austenite and forms curved nest-like figures. This distribution of graphite has been considered to be eutectic graphite.

If the cooling rate be slower, the dissolved gases have sufficient time to collect in minute blowholes, from which the graphitisation begins to progress. The cementite that solidifies in succession

[6] Sci. Rep. 10 (1921), 273.
[7] Internationale Zeitschrift für Metallographie 1 (1911), 184.
[8] Jour. Institute of Metals 28 (1922), 414.

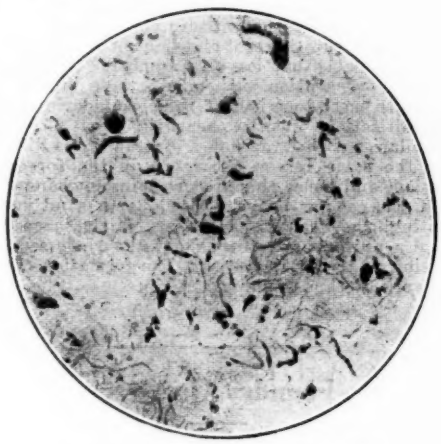
is soon decomposed into graphite and ferrite, the former combining with the already existing graphite; thus graphite grows in large flakes in an ordinary grey cast iron.

If the cooling rate be intermediate between those of the above two cases, the graphite is also of moderate size and in intermediate curvatures.

Moreover, even if the graphite has a tendency to grow into large flakes during a slow cooling, its growth is much hindered by the presence of primary dendritic austenite, so that the graphite is shown curling round the island of austenite in Micro. No. 4. In the case of cooling at this rate the dendritic structure of the primary austenite is not yet perceptible owing to the bordering graphites.

If the cooling rate becomes slower, the graphite round the dendrite gradually intrudes into the area of austenite in virtue of the surface tension at high temperature, the whole area of the alloy showing uniform graphites-in-whirl. Examples of such structures are seen in Micros. Nos. 1 and 4.

Thus there are two kinds of whirling graphite, one being the wormlike graphite in the eutectic area and the other the graphite-in-whirl, which is coarser than the former. These two kinds of graphite, as well as the ordinary platey graphite, are obtainable by adjusting the rate of cooling. Though the rate of cooling is the main condition for obtaining the "Kikumé Structure" in cast iron, there is also another of a less importance, *i.e.*, the composition of the relative area of primary austenite to Ledeburite.

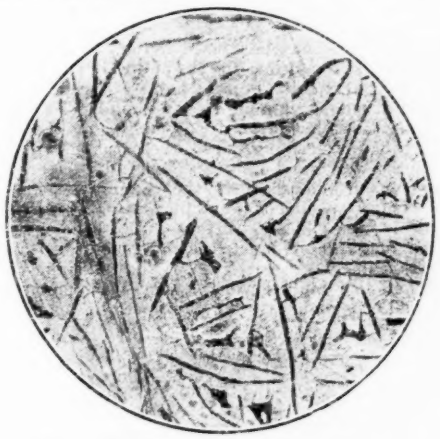


Micro. No. 4—Unetched × 80 dias.

If the carbon content is far below the eutectic concentration, *i.e.*, some 2 per cent., the eutectic area is so small that the typical structure of graphite-in-whirl does not appear. If, however, the carbon content is as high as 4 per cent., the eutectic area is so large that whirling graphite can only be obtained by a rapid cooling. From these facts it is to be concluded that there must be an appropriate composition in which a Kikumé structure can be obtained by the ordinary cooling rate occurring in a green-sand mould. This is the case with approximately 3 per cent. of carbon and 2 per cent. of silicon, as has been already mentioned by Dr. Ishikawa. The cooling rate of the sand mould is, however, sometimes so slow that we cannot obtain this structure of graphite. In such cases, as will be shown later, an addition of a quantity of manganese, copper, nickel, sulphur, etc., has the effect of improving the form of graphite.

To confirm the above view of the mechanism of whirling graphite the present writer carried out another experiment with nickel-carbon alloys. According to Friedrich and Leroux[9], nickel dissolves a quantity of carbon completely in the liquid state, but partially in the solid, the eutectic composition lying between 2 and 2.5 per cent. of carbon.

In hypo-eutectic alloys, the nickel dissolving a small amount of carbon should separate as dendrite and, on a further cooling, the eutectic crystallises in the interstices of the primary dendrite; but as seen from the preliminary experiment in these alloys, the separation of graphite being very rapid, even a fairly rapid cooling did not produce any dendrite, and the platey graphite flakes were uniformly distributed over the whole section. But when they were cast in a heavy chill mould, the primary dendrite and the eutectic were seen from the distribution of graphite. Hence an intermediate cooling velocity between the above two, which is more rapid than in cast iron, should also produce a whirling graphite structure; thus the writer succeeded in obtaining this structure by casting these alloys in a 1 in. gas pipe at the normal temperature.



Micro. No. 5.—Ni-C Alloy × 80 dias.

Thus about 3 kgs. (6.6 lbs.) of pure nickel were melted and about 2 per cent. of carbon was dissolved in the melt. One-half of the melt was cast in a dry sand mould and the other half in a 1-in. gas pipe. Micros. Nos. 5 and 6 show the structure of these bars. A mechanical test was applied to these bars; their strength, as well as chemical analyses, are given below:—

	Total carbon.	Graphite carbon.	Maximum stress
	Per cent.	Per cent.	Tons per sq in.
Sand cast ..	1.89	1.67	5.7
Chill cast ..	1.89	1.79	8.3

In spite of a less quantity of carbon in solid solution, the strength of the chill cast specimen

Micro. No. 6.—Ni-C Alloy × 80 dias.

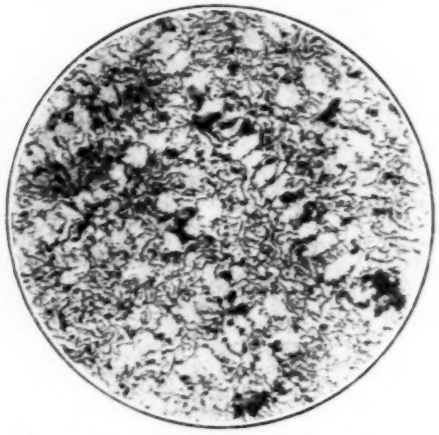
is 50 per cent. greater than that of the sand cast; this must be largely due to the distribution of graphite. Here we see how the strength of a casting is affected by a physical condition of graphite.

[9] Metallurgie 10 (1910), 415.

Cause of Black Fracture and Macrostructure of Cast Iron.

Cause of Black Fracture.

During the experiments above described, the iron cast in a metallic mould showed a black fracture, when the silicon content exceeded 3 per cent.; this fracture is readily distinguishable from the ordinary glittering one of grey cast iron. Sometimes it was confined to the external portion, leaving a sound core, and sometimes extended over the whole section. The microstructure of this black fracture is shown in Micro No. 7; it consists almost entirely of graphite and ferrite, leaving no pearlite in the structure. But the same cast iron in a sand mould had always the normal structure consisting of graphite and pearlite. This black fracture may be caused by the tempering of chilled cast iron below the A, point, if the cooling rate in the vicinity of this point be much slower in a chill mould than in a sand mould. To decide whether this black fracture is caused by the tempering or not, cooling curves were taken both for chill-cast and sand-cast specimens; it was found that for all temperatures the cooling velocity in the former specimen was incomparably greater than in the latter. Hence the above view is untenable, and one must seek for some other cause. For this purpose a cast iron of the following composition was melted with a varying amount of ferro-silicon and cast in the metallic mould at



Micro. No. 7.—Si 1.9 per cent. × 120 dias.

room temperature:—C, 3.60; Mn, 0.288; Si, 0.82; P, 0.0116; S, 0.0045 per cent.; and Cu, trace.

The bar having the original composition had a purely white fracture, but the fractures of other bars changed gradually from mottled white at the centre in specimen No. 1 to wholly grey in specimen No. 4, the silicon content varying from 1.2 to 1.9 per cent.

From these facts the writer concludes that complete graphitisation is partly due to the rate of cooling and partly to the silicon content; it is satisfactorily explained by Professor K. Honda and T. Murakami's theory of graphitisation already referred to. In chill-cast specimens, the gases in cast iron are uniformly distributed as invisible minute bubbles over the whole space, and hence the decomposition of cementite begins to take place from innumerable centres, resulting in small flakes of graphite-in-whirl. The interspaces between these graphites are so narrow that they are within the limit of gaseous diffusion, as a result of which graphitisation easily occurs.

In the case of sand casting, the cooling rate is generally so slow that the gases dissolved have a sufficient time to collect into microscopic blow-holes, from which graphitisation proceeds. In this case, graphite grows in large platev flakes, but these are fewer in number; hence the interspaces between the graphite flakes are too wide to admit of the diffusion of gases, and their greater part remains ungraphitised.

The above difference in the distribution of the gases is easily confirmed when a white cast iron is cast in a sand mould on one hand and in a chill mould on the other. The former shows many blow-holes, while in the latter no trace of blow-holes, even of microscopic magnitude, are observed, the gas bubbles being minutely distributed over the whole area.

Macrostructure of Cast Iron.

By etching a polished section of grey cast iron one often sees with the naked eye a network structure on the surface of the specimen, reminiscent of the grain of iron. It is seen under the microscope that this network structure is caused by the difference in the distribution of graphites. Many, but comparatively small, flakes are seen inside the network, and some large flakes on the boundary; the matrix is everywhere pearlite. Examining the macrostructure of this specimen, using Humfrey's reagent, in the centre of the specimen it was observed that most of the primary dendrites were contained in meshes, while in its outer portion there is no relation between the relative positions of the net-work and the primary dendrite.

No doubt this phenomenon is caused by a rapid cooling during the eutectic solidification. To explain the formation of this net-work structure, one must return to a consideration of the crystallisation and graphitisation in cast iron. On cooling down from the liquid state to the eutectic temperature, the simultaneous solidification of austenite and cementite begins round the primary dendrites in the case of slow cooling, or from independent centres in the case of rapid cooling. The graphite in the first stage of the eutectic solidification is generally of a worm-like nature in virtue of a comparatively rapid cooling, but in the intermediate stage the cooling is just balanced by the heat evolution of the eutectic crystallisation, *i.e.*, the cooling rate is zero, and hence there are large graphite flakes but less in number. When the eutectic separation is ended, these flakes of graphite meet together at their boundaries. The graphitisation in the pearlitic area in these boundaries with large flakes of graphite is difficult for the same reason as stated in the foregoing section, and hence this area remains unchanged.

If the cooling be very slow, as in sand mould casting, the graphite flakes are fairly large and have a uniform size throughout the whole section, leaving no trace of network. The formation of the network is thus explained.

(To be continued.)

Foundry Queries.

Cupola.

I shall be glad of your readers' opinions on the reason why 99 per cent. of cupolas burn back more in one particular spot than in remainder of melting zone.

I have heard three reasons advanced:—(1) Unevenness of blast; (2) unevenness in charging furnace; and (3) poor quality lining.—A Fettler.

Sampling Manganese Steel.

In reply to a query by Mr. Carnet in your issue of February 26, it may be stated that manganese steel can be drilled if suitably prepared. The first essential is to reduce the manganese steel to the martensitic state by a long soaking in the region of 500 deg. This can be done successfully by soaking in lead bath. Generally speaking, a soaking of 2 to 2½ hours will suffice.

The next point to note is that a specially shaped drill is required—with a small angle of clearance. The drill must revolve slowly, and under heavy pressure.

If Mr. Carnet will attend to these points drilling or machining manganese steel can be carried out successfully, though it is not a "commercial" process.

The estimation of C and Mn can then be carried out in the normal manner.—"A. R.," Sheffield.

Krupp in Bosnia.—It was reported that the Krupp concern intended to acquire the Ljubija ironworks in Bosnia, in order to strengthen its position in Yugoslavia; but the report has been contradicted by headquarters at Essen.

Slags and Fluxes.

"Slags and Fluxes: Their Composition and Uses," was the subject of an address by Mr. H. Russell at a meeting on Tuesday, March 3, at the Chamber of Commerce, of the Birmingham Section of the Institute of Metals, to which an invitation had been extended to members of the Birmingham and Midlands Branch of the Institute of British Foundrymen. Dr. L. Aitchison presided. An apology was announced from Mr. Thomas Vickers, President of the Branch, who was kept at home by influenza.

In the course of his Paper, Mr. Russell said the whole of modern metallurgy was dependent on the intelligent use of slags and fluxes. They were concerned in a very vast field, from the ore to the finished alloy, or even to the finished article where any soldering or welding was done. He proposed to deal only with the comparatively small field covered by the crucible non-ferrous process.

Empirical Basis.

Very little literature on the subject was available, and very little scientific work had been done. In many instances certain fluxes were used because they had always been used, while in others fluxes were bought from a foundry requisite supplier, and the user had no idea of the composition. Most of the work had been done by the eye, and no note had been taken of the conditions existing. The result was that fluxes were used in many foundries which were by no means the best. Steel manufacturers demanded an intelligent knowledge of the exact relationship existing between the flux and slag and metal, and the chemical and physical process involved. This was especially noticeable in the Siemens open-hearth furnace (basic and acid) and the electric furnace processes. Certain steel melters would tell them that if the slag was right the metal was sure to be satisfactory. In the crucible steel process very little change had taken place since the process was invented. The usual procedure was practically to add no slag-forming material to the mix. The oxide on the materials, or that found during the melting, floated to the surface of the metal, where it slightly attacked the pot and combined with the silica to form a slag. A quantity of manganese or aluminium was added, just before teeming, to de-oxidise. It must be remembered that the crucible process was purely a melting process and not a refining one. Slags and fluxes could not be of much use in removing many elements which were detrimental to non-ferrous alloys. The purity of the finished product depended on the purity of the materials used, and all impurities which could be eliminated before melting should be. There were, however, certain impurities which could not be obviated, and which were in the molten bath of metal because of the process. The prevention and removal of the impurities were certainly the primary objects of the fluxes, but other considerations must be taken into account. The chief requirements of a slag or flux were:—(1) It should prevent and tend to eliminate all impurities which were not required in the finished product. (2) Where its presence in the finished product was not required (as in the case of certain metallic fluxes), it should not remain. (3) It should retain in itself as little as possible of the metals melted. This was especially necessary when precious metals were being melted. (4) The slag should be capable of being cleanly removed from the metal surface. A viscous slag would naturally be better for this operation, but it must be remembered that a fluid slag was more active than a viscous one. (5) It should attack the furnace walls as little as possible. (6) It should be cheap. Impurities usually took the form of inclusions or gas which were very detrimental in non-ferrous metals. Many non-ferrous metals were required to give a very highly polished surface, quite free from blemish, and inclusions, such as oxides, prevented this and caused a polished surface to be pitted. Dissolved or combined gas, which separated out in cooling, caused hollowness in the casting. These blow-holes caused hollowness in sheet metal, etc., rendering the finished sheet unsuitable for finished goods. Apart from these defects, impurities, such as inclusions and gas, seriously impaired the physical properties of a metal—for example, tensile strength, elongation, etc.—and also interfered with the electrical properties. The melting-point of the metal might be influenced, and there was no doubt that the viscosity was affected. The impurities which occurred when using a gas-fired furnace might not be the same as those occurring in a coke- or oil-fired furnace. The nature of the crucible or containing vessel must be taken into account—whether iron or plumbago or clay, etc.—and the time the metal was in contact with the vessel. Among the sources of impurities were oxide coating, and, in case of sand-castings scrap, such materials as sand and dressing; materials which had been rubbed off or extracted from crucible walls (rough scrap or shearings were more likely to remove particles from the furnace walls than, say, shot nickel); impurities formed by the action of heating gases or fuel and by furnace atmosphere. Undoubtedly the chief gas giving troubles in metals was oxygen.

Classification of Fluxes.

Classifying the fluxes, Mr. Russell said they might be divided into two classes. The first class were those commonly known as fluxes, and which were generally non-metallic, being salts, or mixtures of salts, or neutral oxides such as lime, silica and glass. In this class might be included charcoal and greases. The second class comprised those commonly known as de-oxidisers, which were generally metallic, or in some cases carbides, borides, and sub-oxides of metals. In this class might be included phosphorus and arsenic. The first class of fluxes might be subdivided into those which were used merely as a protective covering for the metal, such as lime, spar, soda ash, glass, etc., and those which were used because it was believed that some definite change was brought about in the molten bath by their use. These included such materials as borax, boric acid, zinc chloride, ammonium chloride, common salt, nitre, etc. Some of these fluxes, such as chlorides and nitrates, volatised very quickly, whilst others, such as borax and boric acid, became fluid and formed a liquid covering over the bath, thus becoming a protective as well as an active agent. Borax was remarkable in its ability to dissolve oxides. One objection to it, however, was that it was expensive; moreover, it was very viscous in the molten state. It was usually mixed with other salts to obtain the desired fluidity and cheapness. Fluospar also had a good dissolving action on oxides of metals, but it had a very destructive action on the walls of the crucible, and was usually mixed with other materials to reduce this action. The action of these fluid coverings was somewhat limited by the amount of stirring or circulation in the metal, for the reaction took place on the surface only. At the same time it must be remembered that all free oxides, *i.e.*, those not in solution, tend to rise to the surface of the metal, being usually lighter than the metal, where they could be dissolved by the flux. It was also possible, in the case of dissolved oxides, that the layer near the surface had its oxide content lowered by solution by the covering, and this would cause the interior higher oxide portion to diffuse to lower oxide portion of surface, to be again dissolved. Thus in time an appreciable amount of oxide might be removed. The object of protecting the metal by molten coverings was, in many instances, not attained, for, apart from the fact that many coverings could be penetrated by reducing gases, the walls of a hot crucible would allow these gases rapidly to pass through them. As to the second section of the class termed fluxes, *i.e.*, those materials added because they seem to have a distinct action on the metal as distinct from those whose primary object was as a covering, Mr. Russell said the generally accepted theory of those of the borax type was that they were said to dissolve the impurities. Those of the chloride type were said to cause the chlorine to react with the oxides in the

metal, convert them into chlorates, in which form they volatilised out or floated to the surface of the metal to be skimmed off. That the action of this class was totally chemical was very much open to doubt. Regarding de-oxidisers, Mr. Russell said this class was generally added just before teeming. This class of fluxes included silicon, manganese, zinc and aluminium. The amount of de-oxidiser to be used could only be ascertained by experiment, depending upon the amount of impurities present and the amount of de-oxidiser that was required in the final metal. In some alloys the flux acted both as a de-oxidiser and as an ingredient of the metal. There was always some risk in the use of this class of de-oxidiser when using a plumbago crucible where carbon was detrimental to the metal. Some of these de-oxidisers would reduce or dissolve carbon from the pot into the metal. Aluminium and manganese were particular instances of this effect. Magnesium was perhaps the strongest de-oxidiser in common use. It was said to be useful in the case of copper castings requiring a high electrical conductivity, and, unlike many other de-oxidising agents, a slight excess did not affect the electrical properties. It was, however, very violent when added to some alloys. Aluminium also had a very strong affinity for oxygen, ranking next to magnesium, but its presence was not always suitable, being often detrimental to certain metals. Manganese came next, and was followed by zinc. Silicon had a considerable affinity for oxygen, but had been largely replaced by phosphorus in the brass foundry. The last-named was universally used in the brass foundry, but care should be taken that the minimum quantity was used. It was usually supplied in the form of phosphor-copper, and 0.1 per cent. of phosphorus was usually enough. Any excess of phosphorus tended to harden the alloys, and it always reduced electrical conductivity. Boron carbide was recommended as a good deoxidiser for copper, having no effect on the electrical properties. Although the action of deoxidisers appeared, at the first glance, to be very simple, they found in practice that they did not behave quite to rule. It was all very well to assume that when the flux had an oxide it floated to the surface. Unfortunately it did not always do so.

Pouring Conditions.

Referring to teeming conditions, Mr. Russell said moulds should be perfectly clean and dressed with a suitable dressing, which would burn completely and cause no inclusions. The metal should be cleared of slag. Personally he was of opinion that a great improvement could be made in obtaining metal free from inclusions by improving teeming conditions. He admitted that in the case of crucible casting improvement was difficult, but its achievement was very desirable. He believed that in many cases slags and fluxes were blamed for faults due to poor teeming conditions. Genders and Haughton had done some work in which they allowed metals to remain molten under various slags for a considerable time, afterwards permitting the metals to solidify. He thought they would find that an ingot thus obtained would be relatively free from inclusions as against metal skimmed and then poured. It seemed that the problem of slags and fluxes was one which needed far more scientific investigation than had hitherto been devoted to it. They must look to every possible source of impurity, as well as the amount and nature of the impurities. The action of fluxes must be sought for in their mechanical and physical action, as well as their chemical action. He thought, further that a covering slag was always advantageous, except, perhaps, in the case of aluminium, and wherever possible a good de-oxidiser should be used before finishing. Last, but not least, teeming conditions should be observed very strictly.

Discussion.

Professor T. Turner said Mr. Russell had quoted the well-known saying that if the slag was right the metal was right, and that, he thought, could be taken as very generally true. In the case of the iron blast furnace, for example, they looked at the appearance of the gas at the top of the furnace and at the slag that was coming from the furnace, and if the slag was right it could be assumed that the work was going on satisfactorily in the furnace itself. The slag was responsible for certain chemical reactions in the furnace, and particularly for the removal of the silica and the sulphur. If the slag running out of the furnace had a proper appearance and was of the proper consistency they knew the composition was suitable to carry out the chemical part of the operation. They also knew that the temperature was suitable to carry out the melting. It was precisely the same in the case of a steel furnace. When they were working a charge in a Siemen's furnace the best indication they could get as to the state of the charge and the condition of the furnace was to take a sample of the slag on a bar. If the slag was penetrated with small blow-holes and so forth they knew that they were either in an initial stage of the process or that the furnace was not working properly. What was true of those two processes, where the slags had essentially a chemical action, was also true in the case of crucible melting. If they were using a flux with which they were familiar and they obtained their slag right they were fairly safe in assuming that what was under the slag was right also. Mr. Russell had very well said that the action of fluxes was not merely chemical but very largely physical, and that was so, particularly in crucible work. It was merely a question of cleansing at a high temperature. They were melting material at a high temperature, the object being to cleanse that material. Manufacturers did a great deal of cleansing at ordinary temperatures, and by studying what went on at ordinary temperatures with known materials they could form a very good opinion as to what would happen with other materials at a high temperature. The commonest cleanser was soap, and by studying what went on with soap and water they obtained some insight into what happened with slag. If they put a small quantity of soap into pure water, they knew how readily it would flow and wet a surface, how easily they would make a lather upon that water and how the soapy water could be used as a lubricant. In precisely the same way the fluxes acted, in many cases; they merely promoted the wetting of the surface. As to exactly why one substance wets another they often did not know. The physical reasons, he believed, were quite complex. One aspect of the matter was the change in surface tension which enabled neighbouring globules to units and so to flow. They had had an illustration given to them of aluminium turnings or filings. If they put them into a crucible and endeavoured to melt them they found they simply would not melt. The oxygen present in the form of oxides on those turnings was very small indeed. If they heated aluminium the thickest film of oxide they could form was not more than a very few hundredths of a millimetre. It did not go on oxidising and oxidise all through the mass unless it was stirred and so forth. But that oxide film or bag, as the lecturer called it, was very tough, and would not adhere to the next film. So they had this very thin film of oxide of aluminium which could not be removed by heating. If they added something to it which acted like soap they enabled the particles to come together. But soap acted chemically as well as physically. If they added soap to hard water a scum was produced which was a definite chemical compound, while if to the soap they added an acid they curdled the soap. So it was with their fluxes. Many of them acted in the first place physically, and then they acted either upon the acid or upon the base, as the case might be, that had to be removed.

Solubility of Gases in Metals.

The lecturer had referred to gases in metals and the methods of removing those gases. It must be remembered that just as salts varied in their solubility in water, so gases varied in their solubility in metals. It must not be supposed that all metals would take up a particular gas with the same readiness, or would retain the same amount in solution. If they took the case of iron, for example, it would absorb many times its volume of hydrogen and very considerable quantities of carbon dioxide. Nickel, he believed, could retain a good deal of hydrogen, too, and in that way resembled iron. But the solubility of carbon dioxide in copper was apparently low. Neverthe-

less, if it was desired to obtain solid castings even with metals which had a considerable power of dissolving those gases it could be done. They could have gases on the surface of the metals, and, provided that the casting conditions were satisfactory, they need not have any trouble with bubbles or blow-holes. The usual course of working was to heat up the metal, get it thoroughly hot and fluid, and if necessary distinctly above the point at which they wanted to pour it. Let it remain quiet, or if they liked to stir it all the better, perhaps, so as to give the gases a better chance of escaping, to give it time to get rid of the excess of gas. If they then poured at the right temperature they had the best conditions for obtaining solidity.

Bottom Pouring.

DR. BROWNSDON said Mr. Russell had touched upon 90 per cent. of their difficulties in the non-ferrous industry when he dealt with the removal of impurities from molten metals. They seemed to be between two stools, however. If they used flux, the trouble was to remove it. He was not ignoring the difficulties, but at the same time he felt that there was the possibility of improvement of the technique in the application of the cleansing properties of slags and fluxes. He also felt that much of the labour involved in carrying out the process was very imperfectly done, simply because the means at their disposal were insufficient to do it more completely. Alluding to bottom pouring, he said it seemed a hopeless proposition to deal simply with the surface of molten metal, which was very liable to oxidation. They went to great pains to clean the metal, and before they knew where they were it had oxidised again. By bottom pouring much of that trouble was avoided. The production of a perfectly sound, homogeneous, clean ingot was undoubtedly one of the problems of the day in the metallurgical industries. Whether it was done as a matter of everyday practice anywhere he very much doubted. He had samples from Germany, America and other countries, which were stated to make metals superior to those obtainable in this country, but on close examination one found these evidently unavoidable defects running throughout the material to a more or less degree. However closely they carried out present-day technique, he felt that they were still liable to come across these defects.

Better Basic Refractories Required.

DR. JOHNSON emphasised the need for a cheap basic material when one had to deal with the cleansing of metals from dissolved impurities—a cheap basic material for making furnaces and crucibles. The elimination, for instance, of arsenic and antimony from copper could be readily effected by certain basic fluxes. The ferocity with which these fluxes attacked the acid lining was very much against them. Again, there was the ever-prevalent trouble of zinc oxide. In all alloys containing zinc they were confronted with the problem of zinc oxide. The zinc oxide might have to be removed more forcibly than scientifically from the surface, and if they could add a flux which would dissolve zinc oxide readily and form a fluid, easily removable slag which would not attack the lining of the furnace or crucible, they would have gone a long way towards solving the problem of producing sound ingots. But it was the refractory character of zinc oxide, when one had to smelt residues containing it, which was a very serious problem. He did not think it had ever been definitely shown to what extent zinc oxide went into solution in the slag and to what extent it remained, should he say, as combined zinc silicate. If it went into solution, they might expect useful results to accrue. They might expect a lowering of the formation temperature of the slag with a certain increase in fluidity and in the working properties of the slag, but if it remained as infusible silicate then they might expect the slag to have a higher formation temperature and to be less easy to work. Personally he was inclined to think that it was more as zinc silicate that zinc oxide existed in the slag.

Electrolytic Processes.

MR. T. TURNER, JUNR., said the steel industry at present was turning more and more to the use of several slags in succession. He asked whether Mr. Russell had any experience of successive slags being used in the case of non-ferrous materials. He also referred to electrolysis or electrostatic deposition as applied to molten metal. If the particles of slag were simply suspended in the metal and not in solution, he did not see why it should not be possible to increase the speed at which they moved upward in the same way as dust from the atmosphere was made to deposit. If, on the other hand, the slag was in solution, then electrolysis might be possible.

THE CHAIRMAN said the crux of the whole matter in connection with fluxes and slags was physical rather than chemical. They had two materials together, one of which they wanted and the other which they did not eventually want. They had to mix them so as to produce a satisfactory chemical reaction, and subsequently to separate them so that they could be handled quite independently. Reference had been made to causing slags to rise to the top. In steel work that was fairly satisfactory. In the case of non-ferrous work the aim should be to devise a flux and slag which would go to the bottom. The thing was not so impossible when they came to consider the lighter alloys—the aluminium and magnesium alloys.

Mr. Russell was heartily thanked for his Paper.

Replying upon the discussion, MR. RUSSELL referred to bottom pouring, remarking that he did not know how far it was possible to make a cheap crucible, having a sort of plug in the bottom by means of which they could tap out, and which would pay for use in one heat. With regard to the use of potassium cyanide as a fluxing material it must be remembered that it was a deadly poison, and unless it was carefully handled there was a chance of someone being poisoned. As to the analysis of slags, he was inclined to agree that the best way to analyse them was under actual working conditions.

London Foundrymen Visit Large Gas Works.

Last Saturday about 40 members of the London Branch of the Institute of British Foundrymen visited the East Greenwich Works of the South Metropolitan Gas Company. The visitors were received by Mr. Macdonald, chief mechanical engineer, who, together with his colleagues, conducted the party through the various departments. Especially worthy of note is the excellent decentralised welfare department. By this is meant that washing and cooking facilities are established in close proximity to where the men work. The works are run on a co-partnership basis, and the employees have now something approaching £500,000 invested in the concern. The works gasify something like 2,600 tons of coal per day, which is brought to the companies staithes by their own fleet of steamers. The importance of the coal gas industry to the foundry trades can be gauged by the fact that the South Metropolitan Gas Company consume inside the works about 800 to 900 tons of cast iron annually, together with about 50 tons of steel castings. A considerable weight of malleable iron is also used. On the mains, however, the annual consumption approximates 2,220 tons.

It is interesting to note that no electrical machinery whatsoever is to be found in the works. Large use is made of hydraulic power, and some splendid engineering feats have been accomplished.

At the conclusion of the visit tea was served in one of the excellent canteens, and many of the above facts were disclosed by Mr. Macdonald in reply to the vote of thanks proposed by Mr. V. C. Faulkner, the Branch-President. The organising of the visit was undertaken by Mr. H. G. Sommerfield, the Branch-Secretary.

HOLLOWAY CASTINGS, LIMITED, are being voluntarily wound up. Mr. G. W. Webb, 99, St. Paul's Road, Highbury, London, N.1, has been appointed liquidator.

MESSRS. J. T. HOBKIRK AND W. J. H. THOMPSON, iron and brass founders, 5A, The Broadway, Bedford, trading under the style of J. Hobkirk, Sons & Company, have dissolved partnership.

De-sulphurisation, Expulsion of Gases and Refining of Cast Iron.

By G. C. CASTLE.

In THE FOUNDRY TRADE JOURNAL of November 27 last Mr. J. E. Fletcher gave a very interesting report upon the use of different fluxes in the cupola, and we have now, in a more recent issue (February 26), the results shown in the foundries of the Griffin Wheel Company, of Chicago, by the use of soda ash. The leading article in the JOURNAL of the same issue calls for further information on this subject in order that the national scrap may be improved by some process of de-sulphurisation.

It is astonishing how British foundrymen cling to the old methods. On a general tour of foundries in this country scarcely one in twenty will be found to be running its cupola plant on up-to-date lines. The same methods have been in use for many years. It is curious to note that all new cupola processes seem to originate in other countries. It is not surprising, therefore, to find that our production costs are high when compared with the foreigner.

It is a well-known fact that the value of a casting is dependent upon homogeneous texture, compactness of grain, strength and qualities which ensure easy machining. It is difficult to obtain these properties with certainty unless a good quality pig-iron is used. Blisters and local hardening of cast iron are caused not only by the gases produced during the melting of the pig-iron and resulting from the combination of iron and oxygen. These defects are largely due to the action of sulphur and inclusions of silicon and manganese compounds which cannot separate from the molten iron, but which are not in actual chemical combination.

By charging into the cupola too large a proportion of high-grade pig-iron the texture of the resultant castings would be too open. On the other hand, an excess of scrap will cause the iron to be hard and blistered in the absence of a proper de-sulphurisation system.

Foundry technology has, during the last few years, pointed to the fact that the conditions induced by sulphur and combinations of iron and oxygen can be successfully overcome. By treating a ladle of molten iron—after the slag has been removed from the surface—with an alkaline earth an immediate strong expulsion of gases will result, and subsequent analysis will show that the sulphur content has been considerably reduced, the iron being compact and easily machined.

As a result of this discovery, melted iron, especially in large foundries, was de-sulphurised in ladles or special receivers by means of a de-sulphurising material named after Walter, the German inventor. Although the results were good, the process had one great disadvantage, inasmuch as the slag produced during de-sulphurisation passed also into the mould by reason of its high degree of fluidity, and thus castings were easily spoilt. It was also impossible to apply this de-sulphuring process in the case of small ladles, as the iron became too cold, and could not be poured into the moulds. Besides these drawbacks, the fumes arising during treatment of the iron proved a great handicap to the workman.

Thus foundry engineers were faced with the problem of arranging for de-sulphurisation and expulsion of gases within the cupola itself. The task was not an easy one, as it is well-known that the slag which is formed by the process of melting in the cupola prevents the discharge of sulphur gas, which is liable to be again absorbed by the iron.

For this reason a means had to be found of separating the iron from the slag, and the German foundry engineer, Carl Rein, devoted many years of research work towards this end. He has invented a successful method of readily separating the slag during the cupola melt, and which has proved its worth in both large and small foundries in Germany and other countries. Additionally, the first equipment in England has also been highly successful.

This process for de-sulphurisation, expulsion of gases and refining can be adapted to every cupola. For this purpose, furnace without receivers must be supplied with one, but there need be no fear that the iron becomes cold by reason of this addition—quite the contrary—as the hot gases arising during the melt are utilised, so that not only does the first iron to run into the receiver possess a very high temperature, but the iron bath is subjected to continual heating during the melt. The slag as it forms during the melt passes into a slag collector, and the hard slag block may be removed the following day.

The process of de-sulphurisation, expulsion of gases and refining is carried out from time to time in the receiver by addition of the de-sulphurising agent through a trap door. The molten iron is then drawn off in the usual way, and run into the ladles. The working of the cupola is not only simplified by this equipment, but is rendered very much cleaner. By the ordinary method of cupola construction the slag must be frequently tapped in order to avoid stoppages. The Rein process entirely eliminates this troublesome operation.

The advantages which foundries acquire from the de-sulphurising, expulsion of gases and refining process are very considerable, and may be summarised as follows:—

(1) The cost of the charge will be reduced, as an excellent compact machinable casting, suitable for all purposes, will be obtained with a charge of 20 to 25 per cent. pig-iron and 80 to 75 per cent. scrap.

(2) Loss of castings through hard spots, piping, blow-holes and cavities in the iron, and also waste owing to cold iron, will be reduced.

(3) The machining of the castings can be carried out more speedily and with less wear on the tools. As a result appreciable savings are effected in the machine shop.

(4) Customers will readily pay a higher price for iron that has been de-sulphurised and refined and is therefore free from defects, because claims, return freights and waste of time will be avoided, and they will benefit by the improved quality of casting.

(5) With the Rein system, melting usually requires less coke, but the iron, notwithstanding this, is raised to a higher temperature. Waste of iron is considerably less, because no losses are incurred, as in the case with the ordinary method of removing the slag, and the slag which passes into the "Rein" collector is free from iron.

(6) Cast-iron scrap, even that which is exceedingly rusty and burnt, iron and steel turnings can be advantageously included in the charge. This economy will be readily appreciated by foundries operating their own machine shops.

It is thought that these factors will appeal to all foundrymen, whether operating large or small cupola.

Iron and Steel Production.

The National Federation of Iron and Steel Manufacturers, in their Statistical Bulletin for January, report that the production of pig-iron last January amounted to 574,500 tons, compared with 580,300 tons in December and 636,600 tons in January, 1924. The production of steel ingots and castings amounted to 605,100 tons, compared with 551,000 in December and 694,300 in January, 1924.

THE ANNUAL BANQUET, conversazione and dance of the North-East Coast Institution of Engineers and Shipbuilders was held on March 6 in Newcastle. Mr. T. Westgarth, the president, was in the chair, and was supported among others by Sir William J. Noble, Mr. M. Gibb, Sir Archibald C. Ross, Sir Eustace H. Tennyson d'Eyncourt, Mr. B. Mott (president of the Institution of Civil Engineers), Sir George Renwick, Bart., Mr. H. B. Toy (president, Cleveland Institution of Engineers), Mr. Andrew Laing (vice-president), Sir Alexander Kennedy (vice-president), Professor J. J. Welch, Mr. A. B. Binns, Mr. Leslie Skinner, Mr. John McGovern (chairman, Middlesbrough Branch, vice-president), M. C. le Maistre (secretary, British Engineering Standards Association), Mr. M. C. James, Mr. H. E. J. Camps (president of Society of Consulting Marine Engineers and Surveyors), and Mr. J. T. Batey.

The Manufacture of Brass Condenser Tubes, with Some Notes on an Alternative Alloy.*

By G. H. Whiteman and A. Spittle.

A condenser tube is described as being "solid drawn," which means that it is one which has no weld or seam, and is produced by drawing down a short hollow-cylinder. In the case of brass condenser tubes, the cylinders are made by pouring molten metal around a sand core contained in a cast-iron chill mould. The subsequent drawing operations are carried out in the cold state on suitable draw-benches. The raw materials used should be of the highest quality obtainable. The copper should be electrolytic, and contain not less than 99.9 per cent, of pure copper. The spelter should contain not less than 99.5 per cent. of pure zinc, and should preferably contain 99.9 per cent., whilst the tin should have a purity exceeding 99.75 per cent. The use of such metals prevents the inclusion of arsenic and antimony, and limits other impurities such as iron and lead to a very small figure. It is not suggested that the latter impurities, when present in a moderate degree, necessarily affect the corrodibility of condenser tubes, but their elimination improves the uniformity of the crystalline structure of the metal, increases the ductility, and tends to reduce the liability to blow-holes and defects in casting.

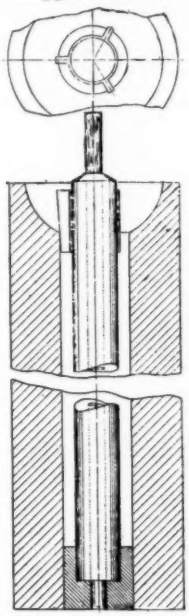


FIG. 1.—SECTIONAL DRAWING OF A MOULD FOR CASTING CONDENSER TUBE SHELLS, SHOWING CORE BAR IN POSITION.

The casting is carried out in heavy chill moulds, either of the split or cannon type. The section of the moulds must be very heavy to ensure rapid chilling. Moulds for casting tubes of 2½ in. dia. are 2 in. thick, a cross sectional area 8½ times the area of the casting. The inside surfaces of the moulds are polished, and they are prepared for casting by coating the surface with a thin layer of a mixture of oil and precipitated carbon, this being dusted over with powdered charcoal. The tops of the moulds are dished. The moulds are fitted at the bottom with a recessed collar to carry the lower end of the core. The latter is held in position at the top by a loose ring, which is a sliding fit on the core, and which has three wings to engage with the sides of the mould, ensuring that the core is central and furnishing a path for the metal to flow into the mould. The cores are made of loam sand and manure ground into a paste with water, and strengthened with a foundation of wood wool. They are built up in four stages around an iron tube perforated with numerous holes for ventilating. In the first stage the core bar is wrapped with a layer of wood wool with a thin layer of loam added. The next stage consists in adding more loam to bring the core nearly to the required diameter. At the third stage the core is finished to size by adding a thin layer of loam whilst revolving the core on trunnions in front of a straight edge. The core is finally washed over with charcoal and water. Between each stage the core is thoroughly dried. After blacking, it is heated for 48 hours before being used. The cores are transferred from the stoves to the moulds a few minutes before casting takes place to ensure that they are warm when the metal is poured. Great care is necessary in making the cores. They must be exact to diameter to secure accurate thickness of the shell, and must be perfect on the surface. Any cracks, spots, or scratches on the cores are reproduced on the insides of the cast shells, and may cause the rejection of the castings. They must be sufficiently porous to permit the passage of gases rapidly.

Brass melting for condenser tubes is almost universally carried out in coke or gas-fired pit furnaces using crucibles of various capacities from 120 to 200 lbs. The casting operation is the most important of all, for on the soundness of the shell depends the quality and suitability of the finished product. Yet it is the operation which calls most for individual skill and knowledge, and is least amenable to control by mechanical or other non-personal means. It depends almost entirely on the skill of the caster as to whether sound castings are produced or not, for if the metal is too hot or too cold, or if it is poured too quickly or too slowly, defective castings result. The fact that electric furnaces and tilting furnaces, which are used successfully in other casting operations, have not supplanted pit fires for melting brass for tubes is not due to lack of enterprise on the part of the manufacturers, but because such furnaces cannot so far be adapted to the delicate operation of pouring into a tube mould.

Casting Shells.

For casting, the various components of the alloy are weighed out in suitable quantities and loaded into iron pans. Each pan contains a charge for one crucible. The copper is first put in the crucible and melted under charcoal, the scrap being next added, and finally the zinc and tin. The scrap mentioned is not various odd materials of unknown origin, but is exclusively confined to pieces of metal cut from tubes of the same alloy during the process of manufacture. It must be understood that an inferior mixture results if only elemental metals are used, hence the addition of a proper proportion of scrap or previously melted alloy is necessary to ensure perfect castings.

When the contents of the crucible have been brought to a proper temperature and thoroughly mixed, the crucible is lifted from the furnace and the metal is carefully skimmed. The crucible is then placed in a carrier which is hung in a stirrup suspended from a runway. The moulds stand in a line parallel to the runway, and are caused to revolve whilst the metal is poured into them. The oil in the mould dressing burns during the pouring operation, and furnishes a strong reducing flame which reduces the oxide formed on the surface of the metal as it flows from the crucible. Great care must be exercised in pouring to avoid splashing and to ensure a regular flow from commencement to finish. The chilling effect of the moulds causes the metal to set very rapidly, so that no feeding is necessary. The castings are withdrawn whilst still red hot. A film of carbon adheres to the casting separating it from the mould, and allows it to be easily extracted. The heat of the casting burns away this carbon immediately it comes into contact with the air, leaving the surface perfectly clean.

* A Paper read before the Institution of Engineers and Shipbuilders in Scotland.

After being withdrawn, the shells are allowed to cool naturally. The cores are then extracted, and the inside surfaces cleaned with a wire brush. The ends of the shells are next cut away with cold saws. The shells are then carefully inspected, and any which show indications of unsoundness, or which are indented or otherwise marked in a manner likely to cause laminations in drawing, are immediately rejected. The remainder are despatched to the tube-drawing mill unless they are specified to be bored, or bored and turned, before drawing. In the latter case they are machined according to specification, and again inspected internally and externally before being sent forward for drawing.

The machining is carried out on special machines designed for rapid output. They will bore the $1\frac{3}{8}$-in. internal diameter shells to $1\frac{5}{8}$-in. diameter at one cut, at a speed of just over 6 in. per minute. The boring and turning removes $33\frac{1}{3}$ per cent. of the weight of the casting. A battery of six machines will bore approximately 500 shells per day, sufficient to make over 25,000 ft. of $\frac{5}{8}$-in. diameter Admiralty condenser tubes after allowing for process scrap and rejections.

It has occasionally been charged against tube makers that the small plugs of copper sometimes found in corroded tubes are the result of bad metal-mixing in the casting process, and that these plugs are small nodules of copper which the caster has failed to melt and incorporate into the brass alloy. Castings such as those just mentioned will be elongated to 25 times their original length, reduced to less than a quarter of their original diameter and to $\frac{1}{16}$ of their original thickness in the process of making condenser tubes. Supposing such a plug of $\frac{1}{4}$-in. dia. could be left unmelted in the original casting, it would be elongated to a length of over 3 in. and drawn to a diameter of $\frac{1}{64}$ in. during the making of the tube. The most casual consideration of the above facts will show how impossible it is for such plugs to be due in any way to fault in the casting of the original tube shells.

All shells are subjected to a preliminary annealing in a closed muffle at a temperature of 700 deg. C. before the first drawing operation. This is intended to remove all internal strains which may have been set up by chilling when cast, and to normalise the crystalline structure.

The drawing operations are carried out on chain-benches using steel mandrels and dies to effect the necessary reduction in diameter and thickness.

A chain-bench consists of a shallow channel-shaped bed with a broad track on either side, usually made of cast iron and supported on cast-iron legs. At the driving end of the bench a sprocket wheel is fitted, over which an endless chain passes. This sprocket wheel is connected with suitable gearing for driving. At the other end of the bench is a drum to carry the chain. This drum runs in bearings which are carried on slides at either side of the bench, and which can be adjusted by tension screws to keep the chain at a proper tension. At the end of the bench opposite to the pulling gear, brackets are fitted to support the die. The chain runs in the channel of the bench, and a pulling dog runs over the chain supported on four wheels which run on the track on either side of the chain. One end of the dog is fitted with pliers to grasp the end of the mandrel, the other end is fitted with teeth to engage in the chain. These teeth are fixed in a counterbalanced hinged-arm which lifts in a vertical direction, so that the teeth are automatically lifted clear of the chain when disengaged.

The mandrel for use on a chain bench is a round bar of steel reduced in diameter at both ends. The ends are slotted or headed for the purpose of engaging with the pliers of the drawing dog. A small turntable is placed on the floor immediately in front of the draw-bench to support the mandrel when the tube is being threaded on to it, and to swing it round when reversing for the withdrawing operation.

The die is a circular or hexagonal piece of steel pierced with a round hole, Fig. 2. The hole is recessed conically to act as a lead for the tube. The pulling-off die is usually of brass, but the hole in this is not recessed. This die must be a good sliding fit on the mandrel to prevent the possibility of the tube being drawn into it and bursting it, instead of stripping off the mandrel.

Tube Drawing.

The tube is first shouldered or swaged. The swaging must be such as to allow for the leading end of the mandrel to pass freely through the reduced portion of the tube, but the reduction must be sufficient to engage tightly with the shoulder of the mandrel, otherwise the mandrel will be drawn through when the drawing operation begins.

When the tube is threaded on to the mandrel, the leading end of the latter is passed through the die and secured to the drawing dog. The teeth of the drawing dog are then allowed to engage with the draw chain, which is constantly travelling along the bench. The tube is thus drawn on to the mandrel.

As the teeth of the drawing dog are held in the chain by tension, the dog is released immediately the tube is through the die, owing to the tension being relaxed. The bench operator displaces the drawing die, and immediately pulls back the mandrel with the tube on it on to the turntable in front of the bench, swings the mandrel round, puts in position the stripping die, and pushes the reverse end of the mandrel through the same. Meanwhile the dog has been returned to the front end of the bench. The reverse end of the mandrel is now secured into the dog, and the teeth of the latter engaged with the bench chain. The mandrel is thus drawn out of the tube, completing the cycle of operations.

After being drawn, the tube is again annealed and pickled. Annealing is carried out in closed-

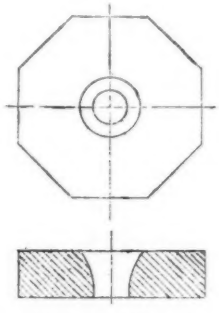


FIG. 2.—DIE FOR DRAWING CONDENSER TUBES.

type furnaces, so designed that the products of combustion cannot come into contact with the metal which is being heated. While this type of furnace involves greater fuel consumption than open or inflame furnaces, the extra cost is offset by the improvement in the quality of the material treated. It is possible to maintain a far more even temperature; there is no possibility of local overheating or burning due to contact with flame; oxidation and scaling is reduced to a minimum; and red staining due to furnace gases is eliminated. These furnaces are specially designed to maintain an even temperature throughout the whole furnace chamber, and are fitted with recording pyrometers so that the temperature can be kept under constant observation.

The tubes are charged into the muffles on wrought-iron pans, which are drawn in by means of a special pulling device operated by an electric motor. After being heated for the prescribed time they are withdrawn at the opposite end of the furnace, and allowed to cool in the pans. When cool, they are lifted from the pans by an electric crane and lowered into the pickling vat, which contains diluted sulphuric acid. When the scale is completely dissolved from the surface of the tubes they are lifted into another vat through which a constant stream of clear water is passing. When thoroughly washed they are allowed to dry. After having the shoulders cut away and being reshouldered, the tubes are ready for the drawing operation to be repeated.

The processes of annealing, pickling, and drawing, using mandrels and dies of gradually diminishing diameters, are repeated until tubes of the required diameter are obtained.

One shell casting is sufficiently heavy to make several condenser tubes. It is, therefore, necessary to subdivide the tubes in process when they become too long for the benches to accommodate them further. The division and trimming is effected by means of circular saws. To accommodate the length of the tubes, the saws are built into and form part of long sawing-tables. To facilitate cutting to length, the sawing-tables are provided with measuring rules permanently attached to the faces, and divided off in both English and metric measurements. At right-angles to the rules sliding stops are provided which can be moved along the tables and locked for cutting off to any desired length. The spindles of the saws have a short projecting mandrel, to which is attached a reamer for removing the burrs from the outside and inside of the tubes after cutting. When the finished tubes have been straightened and cut to length, they are subjected to an internal hydraulic test of 1,200 lbs. per sq. in., or such other pressure as may be specified by the purchaser. They are then submitted to individual examination of the surface inside and outside, and gauging for thickness, diameter, length, and concentricity.

Admiralty Specification.

The British Admiralty, the largest users of condenser tubes in the world, to whom the highest obtainable standard of reliability is the very first consideration, years ago issued a specification to govern the manufacture of their tubes. From time to time this specification has been modified, until it is now by far the strictest specification issued to control the manufacture of any tubes.

The requirements and tests to be met by Admiralty tubes are briefly as follows:—

The castings from which the tubes are drawn must be turned and bored, not less than a quarter of an inch being taken from the bore. All tubes must be tested by hydraulic pressure to 1,000 lbs. per sq. in., the tubes being jarred with mallets while the pressure is maintained; tried with gauges to prove the internal and external diameters, the thickness, and concentricity. The tolerance between the go and not-go gauges being 0.005 in. Hammered on the ends with a mallet whilst held loosely in the hand. Dropped on a hard wooden floor. Flattened at either end to $\frac{1}{8}$ in. without cracking. (In connection with this test, the tubes must yet be hard enough to stand screwing up tightly with tape grommets in the glands of the condensers without collapsing.) Examined on the outside for surface defects. Sighted for internal defects whilst lying on a suitable table, and with the aid of electric light so arranged that parallel rays can pass through the tube.

Tubes which successfully pass all these tests are grouped in parcels of 100, and from each 100 two tubes are selected for heating to redness and splitting open to examine for internal defects. Rejection of 20 per cent. of such parcels may entail the rejection of the whole quantity under survey.

In connection with the sighting test, tubes set apart as doubtful are kept separate from other rejects, and 20 per cent. are cut open to examine the nature of the defects which have caused them to be set aside.

It is obvious that tests such as these rigidly enforced necessitate the greatest accuracy and care in manufacture, otherwise the rejections would be ruinous. The different tests, added to the specification from time to time, have brought forth the various improvements in the process of manufacture necessary to meet them. For instance, the flattening test caused the introduction of closed annealing-furnaces and the use of extra fine metals for making the alloy, as without these it is impossible to guarantee the necessary ductility to withstand the test combined with the requisite toughness to resist collapsing when screwed up. Strict external examination involved improved dies, while the sighting test necessitated quite a number of special devices, the principal being specially finished mandrels, glass hard as to temper of the face and polished like a mirror, means for removing every trace of scale or extraneous matter from the insides of the tubes, and preventing, as far as possible, specks of dust falling on the mandrels during the drawing operation.

A mandrel for making Admiralty tubes is something of an engineering achievement. A full-length bar has a working length of 20 ft., a diameter of 0.525 in. at one end with an even taper of four-thousandths of an inch in the 20 ft., making the opposite end 0.529 in. dia. It must be perfectly round and straight, free from the slightest kink, flexible and tough, yet, as before stated, it must have a glass-hard skin and a surface like a mirror. A mandrel is scrapped when wear has reduced the diameter by four-thousandths of an inch, or when the surface has been scratched or dented.

The specification has, undoubtedly, been the means of greatly improving the quality and the reliability of Admiralty condenser tubes, and it is all to the good that many of the improvements in the manufacturing processes which it has brought about have been adopted for producing ordinary commercial condenser tubes, and the improvements in the latter have been in proportion thereto.

Speaking generally, the reliability of condenser tubes made under proper conditions has greatly improved during recent years, but in spite of all efforts failures still occur, and recently there have been failures of a grave character, caused by a new type of corrosion which seems to be peculiar to ships of certain classes using turbine machinery. These failures are causing serious concern to many engineers, for they usually affect a large number of tubes and are very rapid and destructive in character, so much so that tube failure has been known to commence in new condensers in a few weeks, and total replacement has been needed within 12 months.

It is now fairly well recognised that plain brass tubes, however well made, cannot be depended upon for use in condensers of the character under consideration. Various devices have been suggested to alleviate the trouble. The use of Admiralty mixture tubes coated with tin has proved effective in a number of cases, but the ultimate life of these tubes has yet to be determined. Dr. Bengough recommends artificially coating the tubes with a protective scale, and Mr. Austin, of the Cunard Steam Ship Company, recently read an interesting paper on the use of bitumastic composition as a protective covering.

An Alternative Alloy.

An alternative which is being increasingly adopted on land and sea is the use of alloys tougher than brass and free from zinc. Cupro-nickel is one of the foremost metals of this class in use, and so far has justified its adoption wherever it has been used. A conspicuous case is a power station in the North of England notorious for the rapid destruction caused to brass condenser tubes. In this station 80: 20 cupro-nickel tubes have been in use for nearly three years, and no failure has yet been recorded. So satisfied are the engineers concerned that new installations requiring upwards of 35 tons of condenser tubes are being fitted with cupro-nickel, and it is probable that cupro-nickel will replace the brass tubes in all their condensers as circumstances permit. Upwards of 16 ships are already using or are about to be fitted with cupro-nickel condenser tubes, including two large Atlantic liners which are being entirely retubed with them.

It is only within the last two or three years that it has been found possible to manufacture cupro-nickel alloys containing from 15 to 20 per cent. of nickel in commercial quantities in the form of tubes. The manufacture is attended with many difficulties outside those appertaining to brass, and, consequently, they are relatively more expensive to manufacture. But should they prove to be more enduring than brass, as there is every reason to believe they will, the extra cost of installing them will be many times offset by the reduction in the expenses attaching to the frequent renewals required by the latter.

Laboratory tests extending over two years have been very encouraging, and such reports as have come to hand of their behaviour in service are of a like nature.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Soda Ash and Furnace Linings.

To the Editor of the Foundry Trade Journal.

Sir,—With reference to the article on fluxing slag with soda ash.

May I ask what effect the soda has on the furnace lining?

Yours, etc.,

T. H. Gray.

119, High Holborn, W.C.1.
March 7.

[Undoubtedly if soda ash were added to the charge of an acid lined cupola it would be liable to flux the lining. Even for the ladle it has been suggested that magnesite bricks should be used.—Editor.]

Defacement of Light Grey Iron Castings.

To the Editor of the Foundry Trade Journal.

Sir,—I very much regret that an error crept in my letter to you *re* "Defacement of Light Grey Iron Castings." In describing the size of coal-dust to be used, the term "90 to the square inch" has crept in.

Although this is very obviously wrong, it is worth correcting, and it should read 90 *to one inch*.

May I state that the coal-dust mentioned should be as fine as ordinary domestic flour, and is obtained by working through a silk mesh of the size given.

Should your correspondent have any difficulty in obtaining such material, I shall be only too pleased to forward him the name of suppliers.

Yours, etc.,

G. C. P.

London Branch, I.B.F.

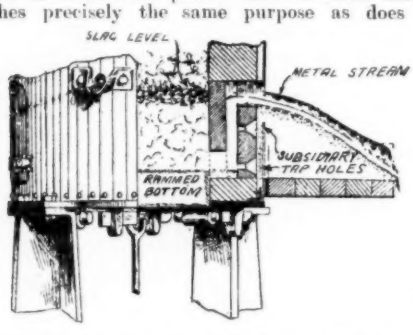
De-sulphurisation of Cast Iron and Syphon Blocks.

To the Editor of the Foundry Trade Journal.

Sir,—Referring to your footnote to my letter on the above subject, published in your issue of March 5, I note that you suggest that M. Ronceray was the inventor of the "syphon block," as applied to cupolas, and I believe that this is so, certainly The Universal System of Machine Moulding and Machinery Co., Ltd., the London representative of M. Ronceray's firm, give an account of the block in their catalogue, and most courteously offer to supply detailed drawings free of cost. And, in fact, the blue print of the Ronceray block bears a very close resemblance to what has been reported as in operation in connection with the de-sulphurising process.

The important factor seems to be, What does such a block accomplish? and has anyone any patent rights to its use?

The answers seem plain. Such a block accomplishes precisely the same purpose as does an



ordinary drain trap! This has a "U" filled with heavy liquid (more or less water), the object of which is to prevent the passage of lighter and undesirable gases.

In the "Syphon" Block—and this is a questionable term, "Seal" being a better word—the "U," one arm of which is the inside of the cupola itself, while the other is the passage leading to the tap-hole, is again filled with heavy liquid (cast iron), the object being plainly to keep back the lighter slag. The block naturally incorporates subsidiary tap-holes for the drainage of the cupola.

Such an arrangement, moreover, should be capable of application in any process which requires a metal free from slag.

The blue print supplied by M. Ronceray's firm shows three tapping positions: (1) On bottom of cupola level and (2) immediately over it. Now, one interesting point transpires, and it is this. The block described as most successful in connection with the de-sulphurising process has also three tap-holes. The bottom one being plainly for emptying the cupola, while the middle one is the one for normal use.

The topmost tap-hole is used for a peculiar purpose, and is opened in event of a stoppage taking place, with the effect that after a time, circulation is again set up in the "U" owing to warm metal, in motion, getting down and melting up the set metal.

In operation, however, with a properly made block, little trouble of this kind is experienced.

One distinct difference, however, must be mentioned in the block recommended in connection with the "Walter" de-sulphurising process, the passage leading to the tap-holes is shallow and wide, which fact should have a considerable effect in decreasing any liability to stopping up.

A point which strikes the writer is this, that the remaining gadget, recommended in connection with the "Walter" process, and believed to consist of a closed-in slag (cupola) chamber, is a pure trade freak, and that a tipping fore hearth, as described in your article on the process at the Griffen Wheel Company, supplies the very best solution for dealing with the basic slag, which is an exceedingly awkward material, particularly in an open top pouring shank. Moreover, in many cases, bottom pouring ladles should be quite well worth considering.—Yours, etc.,

45, Synge Street, Dublin. H. Grattan.

[Whilst it is generally understood that Mons. Ronceray is the inventor of the Syphon Brick, he has not patented the system.—Ed.]

Draughtsman and the Foundry.

To the Editor of The Foundry Trade Journal.

Sir,—I desire to thank Mr. Warnock for his reply to my Paper on "Foundry Work and the Draughtsman" (see January 22, 1925, issue).

I am pleased we are in agreement as to the necessity for co-operation between drawing office, pattern shop and foundry.

Referring to Fig. 4 of my article, I would point out the core will not take away any dirt that is in the mould, nor will a riser. Mr. Warnock insists that dirt was the fault with his castings; but if the cylinders were only small ones, say 2 to 3 cwt., with 1 in. of metal on the top for machining, and assuming a clean mould filled with a good iron, well fed with a rod and made as shown in Fig. 1 in his article, there is no reason why this should not invariably be a good casting; if it is a much larger bowl, say anything up to 5 tons, it should also be satisfactory, as the size of the casting governs the making of the job.

If a head is cast on these bowls, say 9 in. to 1 ft., then the dirt is caught, as well as the dross which forms in a mould of this size. The head also puts on pressure and eliminates the spongy parts that usually appear if feeding is only relied on and the head is done away with.

The shape of the core in Fig. 2 in Mr. Warnock's Paper is, in my opinion, quite wrong, and only increases the amount of work and induces additional risk of bad castings. The neck is not as good a bearing for the shaft which goes through the bowl when finished.

I should like to know what benefit is received from the bottom side of this core, **Fig. 2**. Obviously there is none, and also none from the top if made correctly and cast with the proper iron, the gate being kept full when casting, as was pointed out in the original Paper. (See the Journal, April 24, 1924.)

I have made these bowls for rubber-bleaching and rolling-mill machinery for thirty years. About thirteen years ago I made two bowls without heads according to office instructions. The size of the

bowls were about 9 ft. long and 14 in. dia., but they were both bad. After the firm saw them machined they decided to follow my suggestion and have heads cast on, which method gave good castings. Cylinders of this type practically never show up a fault in machining.

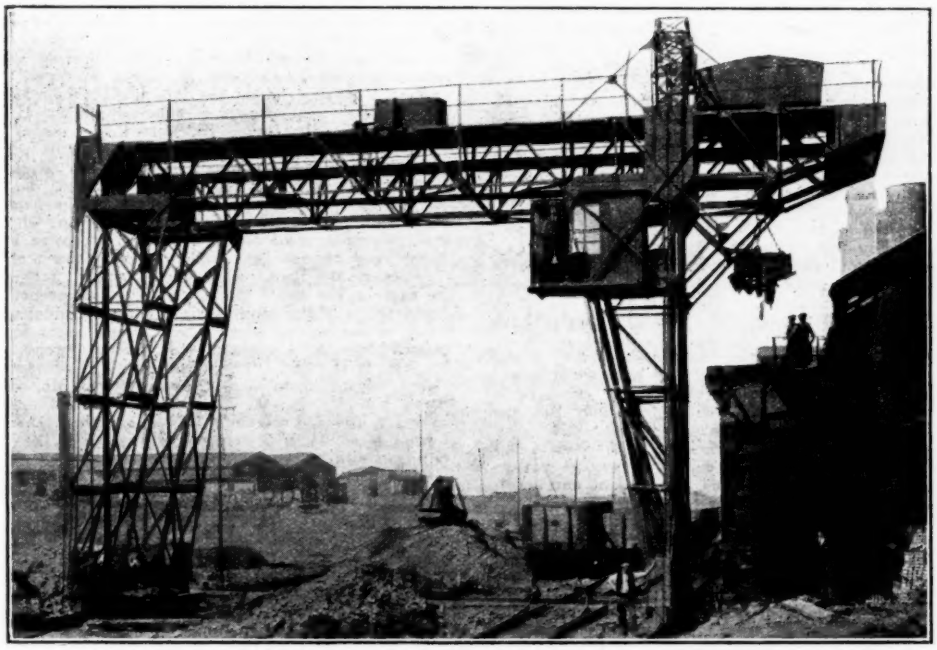
All the bowls I make are fed with a rod, as well as with the superimposed head, and are cast from the top with hot iron.—Yours, etc.,

A. SUTCLIFFE.

Bolton.

Goliath Electric Travelling Crane at Llanelly.

In our issue for March 5 we published an article descriptive of the works of the Llanelly Foundry and Engineering Company, Limited, in which reference was made to a Goliath crane serving the stocking ground and charging platforms. By the courtesy of the makers, Messrs. Joseph Booth & Bros., Limited, Rodley, Leeds, we are able to give the following further particulars accompanied by an illustration of the crane in operation. As stated in the article already mentioned, the crane is of 7 tons capacity, and is electrically operated. The span is 45 ft. between rail centres; cantilever end, 12 ft.; clearance under girders, 32 ft. The lifting magnet is 52 in. dia., being provided with suitable slings and cable drum. The hoisting speeds are as follow:—7 tons at 50 ft. per min.; 3 tons at 100 ft. per min.; travelling: 7 tons at 250 ft. per min.; cross traverse: 7 tons at 120 ft. per min.



GOLIATH ELECTRIC TRAVELLING CRANE AT THE WORKS OF THE LLANELLY FOUNDRY & ENGINEERING COMPANY, LIMITED.

THE RIGHT HON. NEVILLE CHAMBERLAIN, the Minister of Health, was the principal guest at the annual dinner of the Institute of Metals on March 11 at the Trocadero Restaurant. The chair was occupied by the president of the institute, Professor T. Turner. Among the company were Sir Frank Heath, Sir Thomas Rose (vice-president), Sir William Ellis (president of the Iron and Steel Institute), Sir Charles A. Parsons (president of the Institute of Physics), Mr. H. M. Morgans (president of the Institution of Mining and Metallurgy), Mr. Tom Westgarth, Mr. R. O. Patterson (president of the Institute of British Foundrymen), Mr. W. H. Patcheli, Dr. W. Rosenhain, Col. W. F. Cheesewright, D.S.O., Mr. E. M. Boote, Mr. V. C. Faulkner, Dr. W. H. Hatfield, Mr. J. E. Hurst, Dr. R. S. Hutton, Mr. Wesley Lambert, Mr. F. C. A. H. Lantsberry, Mr. A. H. Mundey, Mr. J. G. Pearce, Mr. N. Richardson, and Mr. H. B. Weeks.

Company News.

Mirrlees Watson Company, Limited.—Dividend, 10 per cent., less tax.

Coltness Iron Company, Limited.—Dividend on ordinary shares, 10 per cent. for year.

James Allan, Senior, & Son, Limited.—Capital £10,000 in ordinary £1 shares. Iron founders.

William Cooke & Company, Limited.—Half-year's dividend, 5 per cent. on cumulative preference shares, less tax.

Alley and MacLellan, Limited.—Depreciation, etc., £10,572; carry forward balance, £6,676; no dividend on ordinary shares.

Fricker's Metal Company, Limited.—Net profit, £3,164; brought forward, £4,076; available, £7,240; preference dividend paid; carried forward, £3,657.

Cammell, Laird & Company, Limited.—Profits, £70,894; final dividend, 2½ per cent. for year on cumulative preference shares; no dividend on ordinary shares; carry forward, £45,000.

British Insulated and Helsby Cables, Limited.—Final dividend, 5 per cent. actual and bonus 5 per cent. actual, making 15 per cent. for year; depreciation and reserve, £334,000; carry forward, £221,000.

Delta Metal Company, Limited. — Net profit, £41,039; brought forward, £13,323; dividend, 12½ per cent., tax free; reserve against premises, etc., £10,000; general reserve, £50,000; carried forward, £12,488.

W. Canning & Company, Limited.—Profit, £42,372; brought forward, £3,575; available, £45,947; dividend on ordinary shares, 10 per cent. per annum, less tax, £23,250; reserve fund, £15,000; employés' benevolent trust fund, £1,000; carry forward, £6,697.

Scottish Iron and Steel Company, Limited.—Profit, £55,228; interest on debentures, £4,892; debenture sinking fund, £21,358; balance, £28,978; preference dividend account, £18,000; ordinary shareholders' profit appropriation account, £10,978; ordinary dividend, 4 per cent., less tax.

Stewarts and Lloyds, Limited.—Depreciation, £100,000; preference and preferred ordinary dividends paid; dividend for 1924 on old deferred shares, 2s. 6d. per share, less tax, and on new deferred shares, 5d. per share, less tax; reserve, £50,000; employés' benefit reserve, £10,000; carried forward, £123,000.

Swan, Hunter and Wigham Richardson, Limited.—Net profit, £340,467; brought in, £46,499; further dividend, 5 per cent. on ordinary shares, free of tax, making 8 per cent. for year, free of tax; reserve, £70,000; reserve for equalisation of dividends, £70,000; benefit of employés, £5,000; carried forward, £42,948.

Clarke, Chapman & Company, Limited.—Net profit, £41,389; depreciation, £12,425; directors' fees, £1,500; brought forward, £3,428; available, £30,892; interim dividends, £13,546; final six months' dividend, 7 per cent. per annum on preference shares, £2,444; final dividend, 6d. per share on ordinary shares (making 1s. per share), £11,101; carry forward, £3,799.

Trade Talk.

Sutcliffe Bros. & Boyce, Limited, of Hyde, have appointed Mr. L. C. Brocks as one of their London representatives.

Sir Park Goff, M.P. for Cleveland, is taking part in a movement to form an Iron and Steel Trade Committee in the House of Commons.

An explosion which recently occurred at a furnace at the Oldside Ironworks, near Workington, resulted in the top of the dust cover being blown away.

Ravenshaw & Dyer, consulting engineers, Rutland House, Golden Manor, Hanwell, London, W.7, have removed to Carbon Chambers, Hall Gate, Doncaster.

The Steel Company of Scotland, Limited, have decided to close down their entire rolling mill plant at the Hallside Steelworks, for an indefinite period.

The Glasgow Corporation has decided to divide a contract for water-tube boilers between Vickers Spearing Boiler Company, Limited, and Babcock & Wilcox, Limited.

A subsidiary firm associated with Furness, Withy & Company, Limited, have placed in Germany the order for five 10,000-tons deadweight motorships of 7,000 b.h.p.

A contract for a carillon of 53 bells and a clock for the new Victory Tower on Parliament Buildings at Ottawa has been awarded to Gillett & Johnson, of Croydon. The price quoted is $53,930 (£11,320).

The business of Chas. Martin & Company, Limited, Kelvin Works, South Shore, Gateshead, is being offered for sale by private treaty. The works are well known for their capacity for gear cutting up to 8 ft. 6 in. diameter.

A conference between the Amalgamated Engineering Union and the National Brass and Metal Mechanics' Union at Oldham has resulted in a settlement of the strike at the works of Platt Bros. The men have resumed work.

An accident at a Tees-side ironworks, on March 14, resulted in the deaths of two men, who were severely burnt by the sudden collapse of scale in the flue of a furnace which they were cleaning. The furnace was at W. Whitwell & Company's works, Thornaby-on-Tees.

John Bowling & Company, Limited, have now concentrated their activities in their new premises, Cyclops Foundry, Kirkstall Road, Leeds, which are electrically equipped throughout, and are capable of handling castings from 1 oz. to 25 tons. This is now their registered address.

The London Midland and Scottish Railway have decided to carry out an elaborate scheme of alteration and building at their Crewe locomotive works. Plans have already been passed, and the work, which will provide employment for a great number of men, is to begin immediately. The scheme is largely the outcome of the increased size and weight of modern locomotives. Engines which have become out-of-date are being broken up and replaced by others more powerful and economical, which need larger plant and appliances for their maintenance and workshop handling. At the present time the London Midland and Scottish works at Crewe can turn out every year, amongst other things, 70 new engines, and can deal with 1,200 heavy repair jobs. When the improved arrangements have been completed these figures will be increased in many respects by nearly 50 per cent. The old erecting shops are to be reorganised and provided with high-speed electric cranes, while a large new erecting shop will be built. To meet the demand for new boilers the old works are being converted into a boiler building shop. Included also in the scheme is the remodelling of all the steel plant and the introduction of newer types of appliances. Old furnaces are being pulled down and replaced by others larger and more up-to-date. The alterations will entail an expenditure of nearly £500,000.

Contracts Open.

Felixstowe.—Storage tanks, second-hand, cast or wrought iron, total capacity 50,000 gallons, erected on foundations at Felixstowe. Secretary, Gas Company.

London, S.W.—Travelling cranes, for the South African Railways and Harbours. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Ref. A.X. 1789.)

London, S.W., March 24.—Sleeper pots, etc., for the Madras and Southern Mahratta Railway Company, Limited, viz.: (1) Fittings for cast-iron sleeper pots for B.S. 90-lb. bull-headed rails, comprising 67,200 wrought-iron tiebars, approximate weight 945 tons, 134,500 wrought-iron cotters, 35 tons, 134,000 wrought-iron gibs, 13 tons; (2) 18,600 steel dogspikes for B.S. 60-lb. F.F. rails (approximate weight 166 tons). The offices of the company, 55, Buckingham Palace Road, Westminster, S.W.1. (Fee £1 1s each, non-returnable.)

Obituary.

Mr. J. Thomas, who died recently, at Brierley Hill, near Birmingham, was head of the laboratory at the Earl of Dudley's Round Oak Iron & Steel Works, Limited. He was the first chemist to be employed by that firm, and had been associated with it for nearly 30 years. He was a member of the council of the South Staffordshire Iron & Steel Institute and the Birmingham Metallurgical Society.

Mr. D. D. Ballantine died at his residence, Roman House, Bo'ness, on March 6 at the age of 72. The deceased gentleman was the senior partner of the firm of A. Ballantine & Sons, New Grange Foundry, Bo'ness. The business was founded by the father of the deceased, Mr. Archibald Ballantine, nearly a century ago, the original premises being situated on the foreshore at Forthbank. In 1878 the New Grange Works were opened, and soon thereafter the elder son, Mr. David Ballantine, having completed his apprenticeship, joined his father in the management of the business. Later on the younger brother, Mr. Archibald Ballantine, was assumed as a partner, and he attended to the commercial side. During the war the foundry reached its high-water mark in point of output, and employed 500 hands.

Mr. R. Harvey died, recently, at his residence, Oaklands, Sherbrooke, Pollokshields. The deceased gentleman was the late chairman of the Harvey Engineering Company, Limited, Glasgow. Mr. Harvey, who was in his 76th year, was a native of Glasgow, and spent practically all his professional life in connection with the engineering industries of the city and the West of Scotland. About 1870 his father started new engineering works in Kinning Park in company with his sons. In 1880 Robert Harvey, sen., retired, and Robert Harvey, jun., became senior partner, with his brother as works manager. In 1886 Mr. Harvey joined the late Sir William M'Onie to form M'Onie, Harvey & Company, with Mr. Harvey as managing director. Later still the name was changed to the Harvey Engineering Company.

Mr. E. W. Swan died, recently, at Highfield, Grove Hill, Middlesbrough. The deceased was one of the oldest and best-known figures in the iron and steel trade on Teesside. The late Mr. Swan, who was head of the firm of Swan Bros., of Exchange Place, grew up with the iron trade. As far back as the 'Sixties Swan Bros. were the leading merchants in iron in the home trade. They had opened out business with Scotland, and laid the foundation of what was to become one of the principal areas for the consumption of Cleveland iron. There were three brothers in the firm. The eldest, Mr. J. E. Swan, had charge of the business in Glasgow, while Mr. H. A. Swan and Mr. E. W. Swan looked after the firm's interests in Middlesbrough. At one time Swan Bros. owned steamers which plied between the Tees and Grangemouth.

Personal.

Mr. A. E. Evans is retiring from the secretaryship of W. Canning & Company, Limited, and will be succeeded by Mr. Ewens, the present assistant secretary.

Mr. J. Marshall has retired from the general managership of C. & L. Hill, iron and brassfounders, Sandbeds, Wittenhall, and has been the recipient of a number of presentations from the staff and employés.

Mr. W. P. Gospel, of 65, Seventh Avenue, Heaton, Newcastle-on-Tyne, has resigned the position of hon. secretary to the Newcastle Junior Section of the Institute of British Foundrymen, as he is about to take up a post in London. The secretarial work, until the annual meeting in April, will be carried on by Mr. C. Gresty (hon. secretary of the Newcastle Senior Branch).

Wills.

Ellis, H., managing director of the Elmore Metal Company, Limited	£1,798
Hosken, W. W., of the Waterloo Iron Foundry, Willow Walk, Bermondsey, S.E.	£12,878
Allen, G., of Ipswich, for many years managing director of Ransomes, Sims & Jefferies, Limited	£25,045

Direct Steel Process.—The Swedish Ironmasters' Association has decided to grant a subvention of Kr.25,000 (say, £1,400) to the Uddeholm Company for the experimental production of steel direct from iron ore, according to the method invented by M. Flodin.

The SHOTTS IRON COMPANY, Ltd.

1, Castle St., Edinburgh.

Telephone : 8632 Cent. Telegrams : "Shotts," Edinburgh.

Branch Office—

141, West George St., Glasgow

Approximate Analyses of SHOTTS PIG IRON

FOUNDRY AND FORGE QUALITIES.

	Iron. %	Graphitic Carbon. %	Combined Carbon. %	Silicon. %	Sulphur. %	Phos. %	Mang. %
No. 1	91.38	3.30	.25	3.25	.02	.70	1.10
No. 3 Soft	91.67	3.40	.20	2.90	.03	.70	1.10
No. 3 Medium	91.95	3.25	.35	2.60	.05	.70	1.10
No. 3 Hard	92.49	3.00	.45	2.30	.06	.70	1.00
No. 4 Soft	93.03	2.90	.50	1.80	.07	.70	1.00
No. 4 Hard	93.60	2.75	.65	1.40	.10	.70	.90
Mottled	93.95	2.00	1.50	.90	.15	.70	.80
White	94.35	.60	2.80	.55	.30	.70	.70

Compositions other than the above supplied to specification.

In addition to PIG IRON we are producers of the following :—

Coal for Steam, Gas and Household purposes.
Limestone for Blast Furnaces and Foundries.
Lime for Building, Agricultural Purposes, etc.
Slag for Ballasting and Road Making broken to sizes to suit purchasers.
Shotts Brick for Building Purposes.

Telephone : 21, Penistone. Telegrams : "Durranns, Penistone."

ESTABLISHED 1863.

JAS. DURRANS & SONS., LTD.

Phoenix Works, Penistone NEAR SHEFFIELD.

BLACKING
PLUMBAGO
CORE GUM
WHITE DUST
COAL DUST

Manufacturers of

FOUNDRY EQUIPMENTS.

Ladles, Cupolas, Fire Bricks, Ganister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Write for illustrated catalogue on Blacking and Foundry Requisites, also for our latest Price List.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—The feeling of depression which has overcast the Tees-side iron industry of late evidences, unfortunately, little improvement, business as concerns home consumers remaining dull and uneventful, while on the export side shipments up to date for the month indicate a substantial decrease in tonnage. The real cause of the present dullness, apart from the falling market, may be assigned to the slackness in the consuming industries, the principal factor in which, again, is the inactivity in the shipyards. The whole position is, indeed, one that cannot but occasion serious concern to all interested in the staple industries of this district. Meantime, prices have a weakening tendency, and at this week's market 77s. 6d. was quoted for No. 3 G.M.B., but this was purely a nominal price. Sellers were quoting No. 1 at 82s. 6d., No. 4 foundry at 76s. 6d., and No. 4 forge at 75s. 6d. per ton.

Conditions in the hematite market are without improvement, the home demand being apparently at a minimum, and inquiry from abroad is at a similarly low ebb. For East Coast mixed numbers 84s. 6d. per ton was named, but this is a nominal figure. No. 1 is also nominal at 85s. per ton. Values on the North-West Coast are also weakening in tendency, but are nominally unaltered at previous quotations.

LANCASHIRE.—In the Manchester market for foundry pig the stagnation previously reported is unrelieved, with prices inclined to sag. In the existing circumstances it may be taken as fairly certain that Derbyshire No. 3 foundry iron has been sold at 78s. at the furnaces, and this would mean 85s. 6d. per ton delivered equal Manchester. In this case foundrymen buying now will be at an advantage over those who bought their March supplies last month; and as the competition for orders for castings is unusually keen it is of the utmost importance to have supplies of pig-iron at the very lowest possible cost.

THE MIDLANDS.—At Birmingham market last week there was again only a poor demand for foundry pig, with prices evidencing signs of further weakening. All the furnaces are bewailing the present figures, and speak of producing at a loss; but the demand must govern the price, and consumers are in no mood to buy for forward delivery. Ruling quotations are as follow:—Derbyshire No. 3 foundry, 79s.; Staffordshire No. 3 foundry, 80s.; Northants No. 3 foundry, 72s. to 74s. 6d.

SCOTLAND.—Consumptive demand for foundry iron in this area has reached the minimum level recorded for some time, with prices easy on the basis of 89s. per ton for No. 3 at the furnaces. It is recognised, however, that this figure could be bettered for a round parcel. The prospect of trouble with the engineers is tending to keep consumers from making any substantial purchases.

Scrap.

Reports from the various centres of the scrap metal trade afford scant encouragement to the early prospect of better times in the consuming industries, markets everywhere continuing stagnant in the extreme. In Lancashire there is said to be plenty of common cast scrap in the market at 80s. per ton delivered, but for special "textile" machinery scrap dealers ask 87s. 6d. per ton. Of this class of metal there is no large supply, and hence a fair price can be obtained for it; but ironfounders have been so long accustomed to buying cast scrap at prices very much below pig-iron that they resent having to pay 87s. 6d. for any class of scrap with foundry pig-iron quoted at 86s.

Metals.

Copper.—Values in the standard market, though fluctuations have ruled towards lower levels, may be regarded as fairly steady, with consistent resistance on the part of operators to further declines. The general position, however, remains satisfactory, as it shows the confidence which consumers feel in the future of their trade and in the continuance of the present good volume of business. Consumption here and in Germany, tempted by low offers, has revived somewhat during the past week. French demand, however, remains quiet. Current quotations:—*Cash*: Thursday, £63 7s. 6d.; Friday, £63 12s. 6d.; Monday, £63 5s.; Tuesday, £62 17s. 6d.; Wednesday, £62 10s.

Three Months: Thursday, £64 10s.; Friday, £64 15s.; Monday, £64 7s. 6d.; Tuesday, £64; Wednesday, £63 12s. 6d.

Tin.—Recent movements in the market for this metal have indicated unexpected bear developments, which for the time being have had a depressing effect upon standard values. The fall in quotations led, however, to some satisfactory buying on the part of consumers on both sides of the Atlantic, but after a temporary recovery weakness again set in. A pertinent factor was the sale of over 600 tons of tin by the Straits, which led to hedging sales on the London market. Current quotations:—*Cash*: Thursday, £246; Friday, £249 5s.; Monday, £245 15s.; Tuesday, £241 5s.; Wednesday, £240 15s.

Three Months: Thursday, £249 10s.; Friday, £252 15s.; Monday, £249 5s.; Tuesday, £245; Wednesday, £244 10s.

Spelter.—The market for this metal continues quiet, consumptive demand being affected by the decreased demand in the galvanising industry. The disclosure of the February figures is expected to show another increase in stocks, and it must be said that the prospects of this market have changed very rapidly of late. On the other hand, if the galvanising trade were to revive, an equally rapid turn for the better might come about. Current quotations:—*Ordinary*: Thursday, £35 15s.; Friday, £35 17s. 6d.; Monday, £35 15s.; Tuesday, £35 6s. 3d.; Wednesday, £35 2s. 6d.

Lead.—Conditions in soft foreign pig have been little affected by the general weakness of metals, and have been quickest in recovering. The future position of the metal, however, is admittedly uncertain, due in a measure to the cumulative effect of slackening demand in the States and in France, with a consequent comparative increase in supplies, which may cause lower values to come about here, more especially if Mexican metal makes its appearance on this side. Current quotations:—*Soft foreign (prompt)*: Thursday, £37 1s. 3d.; Friday, £37 12s. 6d.; Monday, £37 12s. 6d.; Tuesday, £37 7s. 6d.; Wednesday, £36 17s. 6d.

A Novel Competition.

We acknowledge receipt of a cheque value £100 from the General Refractories Company, Limited, of Sheffield. This money is the prize fund for a constructive competition the details of which are announced in the advertising columns. We believe that, if foundrymen tackle the problem seriously, information should be forthcoming which should be of considerable benefit to the cast-iron industry as a whole, as it will enable the General Refractories Company better to visualise and meet the requirements of modern cupola practice as a nationally expressed proposition.

Whilst we have not been asked, we so appreciate the potential value of this type of competition that we offer our services in any capacity to help with the work of judging the submissions.

House Fund for the Institute of Metals.

It was announced at the recent annual meeting of the Institute of Metals that a gift of £1,000 had been received from Mr. L. Sumner, a past-president, as a subscription towards the provision of suitable premises.

The aim of the Council is to secure £10,000 with which to purchase a building or from the income thereof to pay the rent of larger premises that the growing work and activities of the Institute render so necessary.

Subscriptions, which will be acknowledged in these columns, should be sent to Mr. G. Shaw Scott, Secretary and Editor, at 36, Victoria Street, London, S.W.1.